One School One Planet

Climate. Education. Innovation.

Permaculture in Schools Programme

Booklet 1 (Units 1-6)

Steven Jones and Jack Hunter

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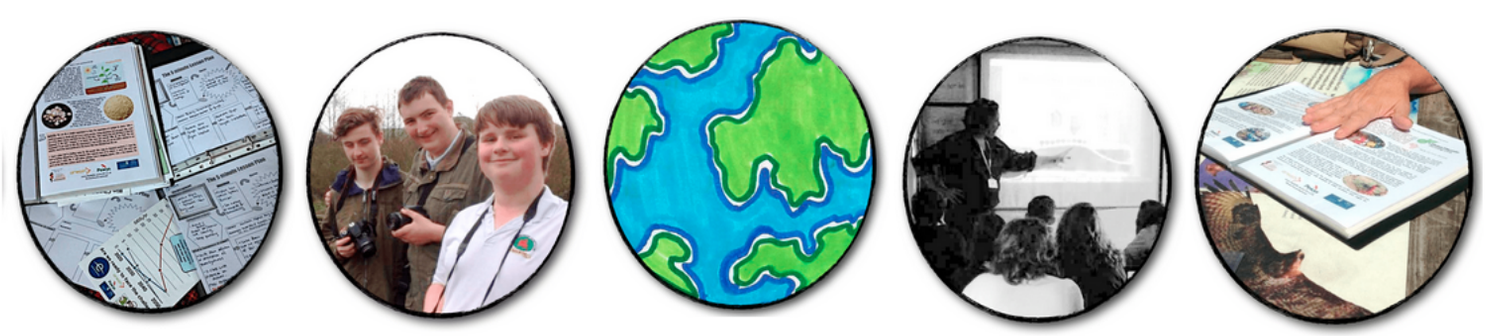

Permaculture in Schools Programme

Booklet 1

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Permaculture in School Programme.
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By Steven Jones & Jack Hunter, PhD.

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Cronfa Amaethyddol Ewrop ar gyfer Datblygu Gwledig: Ewrop yn Buddsoddi mewn Ardaloedd Gwledig
European Agricultural Fund for Rural Development: Europe Investing in Rural Areas

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Contents

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Powys

Cronfa Amaethyddol Ewrop ar gyfer Datblygu Gwledig: Ewrop yn Buddsoddi mewn Ardaloedd Gwledig
European Agricultural Fund for Rural Development: Europe Investing in Rural Areas

Llywodraeth Cymru
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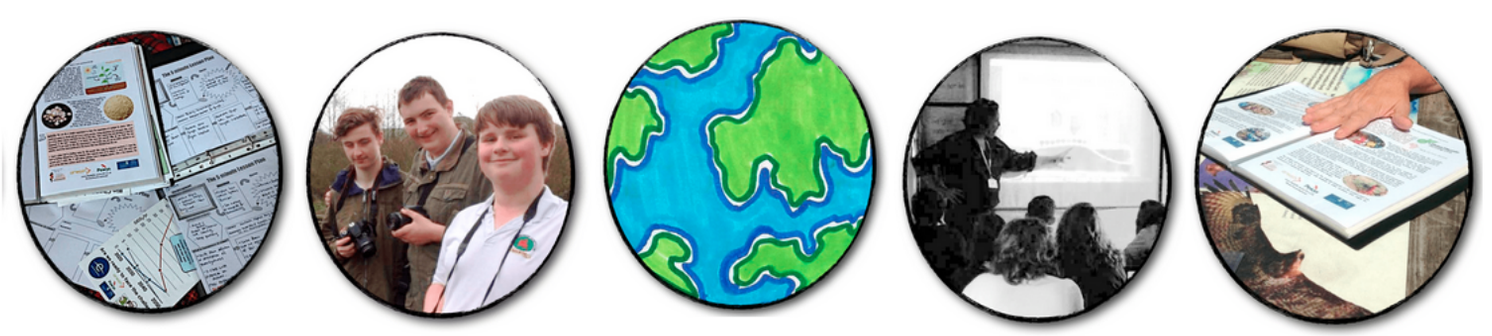
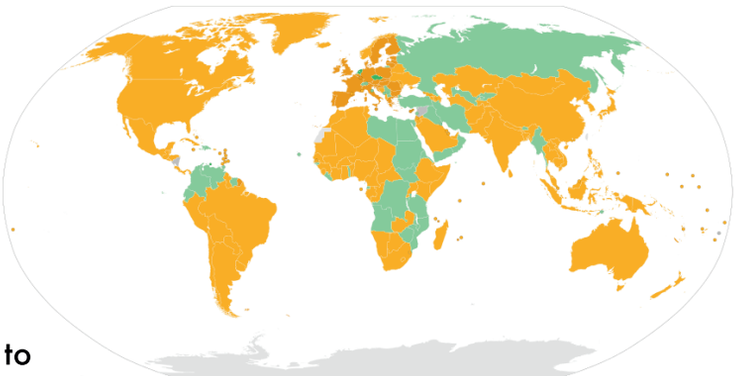


Introduction

The Paris Climate Accord



197 countries signed the Paris Climate Accord in December 2015. This science-based treaty sets out the optimum path for humanity to avoid disastrous runaway climate change.

In fact, it doesn't go far enough. Adhering to its targets only gives us a 66% chance of avoiding catastrophe; Nicaragua - one of the two nations who refused to sign it - withheld their support on the grounds of lack of ambition and enforceable targets in the treaty.

Young people currently at school are growing into a world that will be dominated and defined by the content and implications of the Paris Climate Change treaty. It will colour their whole lives, and they must be prepared emotionally, intellectually and academically for what is coming.

Education Has a Key Role to Play

Political forces, performance targets, external assessment: there has never been more pressure on educators to conform to and perform to external agendas, mandates and dictates.

Here at the 'One School One Planet' project we fully recognise current limitations and do not wish to put any additional pressure on school time and curriculum with our own objectives and agendas. We are here to make your job easier!

This project has a key role to play in facilitating schools to adapt to the changes that face us. It is essential that we incorporate these critical ideas into the academic culture.

Our project proposes cross-curricular themes, new content, facilitation and inter-school links to enable establishments - on a school by school basis - to respond to this huge challenge and to incorporate these ideas into their educational output and campus culture.

This project proposes that permaculture design needs to find a place at the heart of our educational values. We suggest that the permaculture approach can

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Ewrop yn Buddsoddi mewn Ardaloedd Gwledig
European Agricultural Fund for Rural Development:
Europe Investing in Rural Areas

Llywodraeth Cymru
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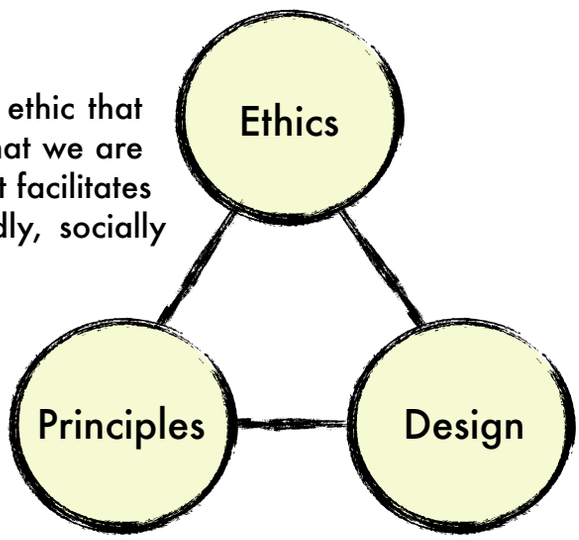
contribute meaning, rationale and action to the educational process. Moreover, it achieves this in a way that encompasses the huge and all-embracing challenge of climate change and the consequent re-evaluation of development objectives and outcomes.

What is Permaculture?



Permaculture is a design system founded on a triple ethic that recognises the Earth's biosphere as a living system that we are all a part of. It enables strategic change in a way that facilitates the designer to steer a path towards climate friendly, socially and economically sustainable outcomes.

We want to create the next generation of leaders and believe that Llanfyllin High School can be at the epicentre of an educational shift that will help to re-shape the world.

Permaculture in Schools Programme

This project has developed a scheme of work based on permaculture's twelve design principles. It is for students of potentially all ages and can be easily adapted and differentiated for teaching at appropriate levels - for different age and ability groups.

The intention is for this scheme of work to be delivered as a linked programme across several schools at once, whereby students are encouraged and supported to share work and collaborate with each other across different classes and schools in different locations at the same time.

Through the programme, students are exposed to a series of twelve core ideas relating to change, sustainability, ecology, economics and the underlying processes that both shape and change evolution. It examines the origins of the resources on which we depend, and questions the processes and outcomes we create with them.

Materials and facilitation will be provided to help deliver sessions including talks, seminars and workshops. These will be used to stimulate and shape a dialogue around each theme in the scheme of work.

Students are encouraged through discussion and debate to shape their own thoughts and to respond to the material, developing and expressing their ideas in their work.

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Ewrop yn Buddsoddi mewn Ardaloedd Gwledig
European Agricultural Fund for Rural Development
Europe Investing in Rural Areas
Llywodraeth Cymru
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Outputs

Academic work might include essays, coursework and multimedia output produced in individual, group and inter-school work. This, in turn, will lead to student-led action and strategies dealing with areas of opportunity identified in and around the school community. Depending on the curricular requirements of the school, we foresee that these units could be easily incorporated into:

- General studies,
- Welsh Baccalaureate,
- Creative writing,
- Media studies,
- Photography,
- Biology,
- Geography,
- Land Based Studies,
- Mathematics (Statistics),
- Religious Studies,
- Environmental or global dimension cross-curricular themes.

Initially, we imagine students working individually to consider each theme. They could read notes, watch video content and online resources (differentiated for age and ability level), produce artwork, creative writing, spoken word or multimedia content in response to their learning.

Students might then group together to produce newspaper articles, blog posts, video clips, drama and spoken word, making collaborative use of all formats to represent the ideas of their group.

This content can be shared via the internet with students and groups from other schools - and ideally in other countries and cultures - to compare perspectives and to collaborate on producing output, which uses the best content from all contributors.

These outputs will be utilised by the project as resources for further learning and dissemination to inform and stimulate future student groups.

Throughout this whole process Sector39 and 'One School One Planet' will support the students with this work, and will not, therefore, be increasing the work load of busy teachers.

Work with Llanfyllin School and Community

The groundwork for this project was put in place in 2014 when Sector39 took steps to build a relationship with the High School. The aim was to create a track record - complete with case studies of practical implementation of permaculture principles to secondary education - in support of an application for funding from ARWAIN, Powys County Council and the Welsh Government.

Work began on the Cae Bodfach community orchard in 2014. Since then we have contributed to two school Sixth Form conferences, successful school partnership work with the charitable organisation Dolen Ffermio, as well as working with specific subject groups - namely Land Based Studies and GCSE Photography and Design students.

We also won support and endorsement from the outgoing school head, which contributed to our successful bid with ARWAIN in August of 2016. Since that time we have been developing these relationships - as well as working across the wider community - while continuing to recruit and build our core project delivery team.

There is an account of our progress so far at www.llanfyllin.sector39.co.uk. These are the foundations on which we now seek to build by offering this twelve part educational programme.

The project hopes to enable Llanfyllin High School to explore permaculture design as an educational tool for:

- Incorporating an environmental perspective in the school's culture,
- and contributing to bringing that perspective into mainstream education.

We want to facilitate Llanfyllin High School staff and students in becoming leaders and innovators!

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The Project Offers:

- The chance to lead the development of a key subject area, namely how to incorporate climate change education into the curriculum in a meaningful way.

- Twelve themed educational units based on the permaculture design principles.

- We offer the chance for the school to work closely with the project team to incorporate these into ongoing school work.

- The opportunity to develop educational exchanges with project partner schools and communities in Uganda and Kenya.

- The potential for exchange visits with those partner schools in Uganda.

Climate education calls for action and response, beyond academic engagement. This program enables the school to link knowledge to meaningful action, commensurate with the level of urgency and challenge revealed by cutting edge climate science.

To begin, we would like to offer a series of talks and lectures for staff and student groups with the aim of identifying possible ways forward.

We can't pretend to understand all of the limitations and restrictions the school might be operating within, but we would like to begin with a period of constructive engagement with staff and students to explore mutual priorities, creating the potential to begin incorporating the twelve unit permaculture programme fully in the new academic year.

"We look forward to full discussions with the school regarding this proposal and welcome your comments and feedback to enable us to develop this further."

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Global Dimension

Climate change is a global phenomenon and responding to it requires interactions and consensus building on a global scale. 'One School One Planet' are simultaneously working in Central Africa building an alliance of schools that are also embracing permaculture and applying its ideas to their school campuses and surrounding communities.

This process began in 2015 using the Llanfyllin based Dolen Ffermio farming support network. We started by working with staff and pupils at Busoga High School Kamuli, Uganda. This ongoing work is funded by the Welsh Government's Hub Cymru Africa programme. To enhance this connection we are seeking technology and innovation grant funding to enable further developments in this collaborative work.

The Busoga High School Permaculture Club already has its own website at www.busoga.sector39.co.uk. Together with the full support of the head teacher, and participation from key staff members, we have designed and planted a school food forest that will supply vital nutrition and resources to the school and students.

Busoga staff and students are recording the progress of developments and innovations at their school, and are ready and willing to begin a dialogue with Llanfyllin High School (or any other potential partner schools). They intend to use the 'One School One Planet' programme to develop eco-literacy and technology, as well as nutritional and educational themes at the school.

Students of all ages and abilities worked with the Sector39 team to design and plant one acre of productive orchard and garden at their school. A fundamental feature of the design of this orchard is that it is climate resilient, carbon negative and highly productive - all hallmarks of permaculture design.

The students will monitor and report on the ongoing progress of this project and are keen to share an active dialogue with students in other locations who might be interested in or inspired by their work.

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This is just the beginning of the work we are doing. We have met with educational and political leaders in Uganda to develop these partnerships further.

We have identified 70 schools in the central Uganda region who are interested in potentially joining the programme. We have also won the support of the Minister for Education of the Bugandan Kingdom, who would like the region to be Central Africa's leading centre for permaculture and climate resilience.

The Hon. Babirye Mary Kabanda MP is the patron to a key regional school and a model for school development - St Jude's. The Sector39 Ugandan team partners are already beginning to further our working relationship with the school. BEU's Charles Mugarura and S39's Steve Jones met with the Minister for Education Mary Kabanda in June 2017 to discuss opportunities for collaboration.

One of the key technologies we are working with schools to develop is a wood gasification stove. This stove produces smokeless clean energy for cooking, and as a byproduct produces a pure carbon residue - known as biochar - that will be used for soil improvement, animal fodder and water filtration.

This technology offers opportunities for energy saving, pollution reduction and bio-remediation at the same time. It is these kinds of synergies that permaculture seeks to emphasise. Technology, design and climate change mitigation all go hand in hand!

In the slums of Nateete, Kampala, Ali Tebandeke - a true innovator - is seeking to kick-start an urban composting initiative making use of unprocessed waste to turn a squalid unplanned settlement into a green oasis of local food and productivity.

Ali is a Sector39 permaculture graduate and a community leader. He is ready and willing to work with students from around the world to help spread the ideas and inspiration he has found through studying the principles and practice of permaculture design.

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Partnerships in Design and Development

BEU Permaculture

Our partner enterprise in Uganda is comprised of graduates from Makerere University, Kampala. Makerere University is one of the top three business and innovation centres in Africa. Sector39 have a partnership agreement with this dynamic team and will also be bringing this relationship into play in our work with our UK partners on this project. Sector39 director Steve Jones has been invited to deliver a key guest lecture on permaculture and business innovation at the University in February 2018.

Sabina Orphanage and School, Rakai, Uganda

This is another key partnership. Sabina orphanage is located at the epicentre of the global AIDS epidemic. The region, close to the border between Uganda and Tanzania, has also been a leader in the education and social care response to this immense challenge and tragedy. Thankfully, the situation has improved immensely since its height. Here we see ex-Llanfyllin High School student Grace Maycock with pupils at Sabina School in June 2017. Between 2008-10 the school became a lead trial centre for permaculture education in Africa and hosted design input from leading Australian permaculture teachers. The school was the first in Uganda to develop and implement a school-wide permaculture programme, incorporating it into their curriculum and developing several acres of organic perennial food production around the school.

Permaculture Research Institute Uganda

Sector39 has also entered into a partnership with the PRI-UG who has the ambition to develop a range of model farms, schools and projects across the Central African nation. We will also encourage this relationship to strengthen our schools work in the UK.

Permaculture Research Institute Of Uganda

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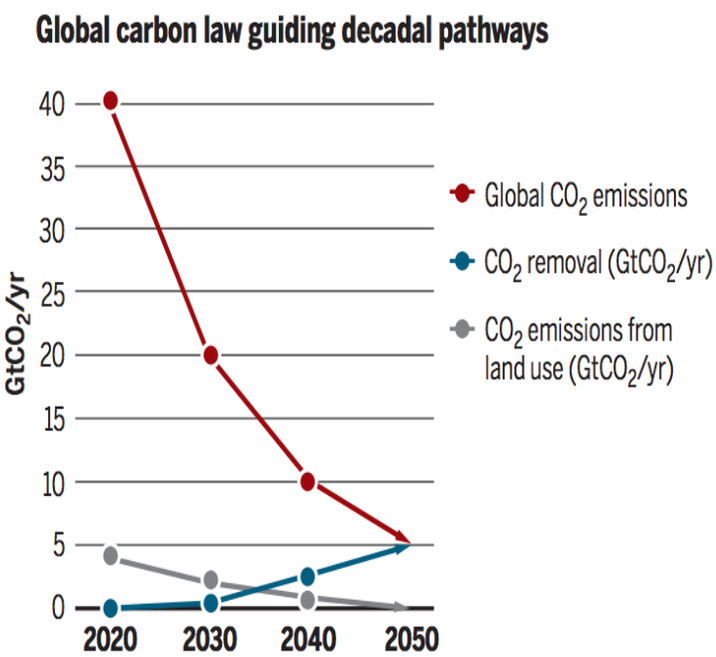
The Paris Climate Agreement in More Detail

197 countries signed the Paris Climate Accord in December 2015. This science-based treaty sets out the optimum path for humanity to avoid disastrous runaway climate change. If we are to be led by science and reason, then we are to be led by the Paris Accord. It is as simple as that. The terms of the Accord are based on the considered response of the greatest global coalition of scientists the world has yet seen - the Intergovernmental Panel on Climate Change (IPCC), and has been negotiating this treaty over a series of 22 international Conferences of Partners (COP).

So, what does the Paris Accord say? Here we break it down into three key ideas:

1: Beginning in 2020, in each of the following three decades the word must halve its emissions of CO2. Although for each successive decade the numbers become smaller the task will become harder as we will make the easy reductions first and leave the most difficult to last.

2: Over the course of those three decades the world must invent and implement effective technologies and strategies for carbon capture and storage. The treaty recognises that these technologies do not yet exist, but anticipates that over a three decade time span they will grow to contribute a 5Gt per annum net sequestration.



3: Agriculture. How we produce our food and manage our landscapes has been singled out for a special role in this unfolding drama. Currently responsible for 5Gt per annum of emissions due to ploughing, land clearance and the widespread use of agro-chemicals, farming is required to transition to carbon neutral by 2050, and towards 5Gt per annum of carbon sequestration over the following decades.

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"Put simply this represents the greatest challenge humanity has ever faced."

It is equal to the changes made to the economy at the onset of World War Two, yet prolonged for three decades. Economy, education, design, planning, technology, farming, arts and culture all need to take note of where we are going!

Environmentalism Goes Mainstream

It used to be the job of fringe groups, hippies and nay-sayers to communicate these messages but those days are far behind us.

The Intergovernmental Panel on Climate Change (IPCC) and the Conference of Partners (COP) couldn't be more mainstream, and the scientific weight behind their findings is immense.

We simply cannot afford to ignore the messages coming from the climate scientists. Embracing this evolutionary leap forward is the central arena for innovation and opportunity for the coming decades.

IPCC
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

There is an Answer: Permaculture Design

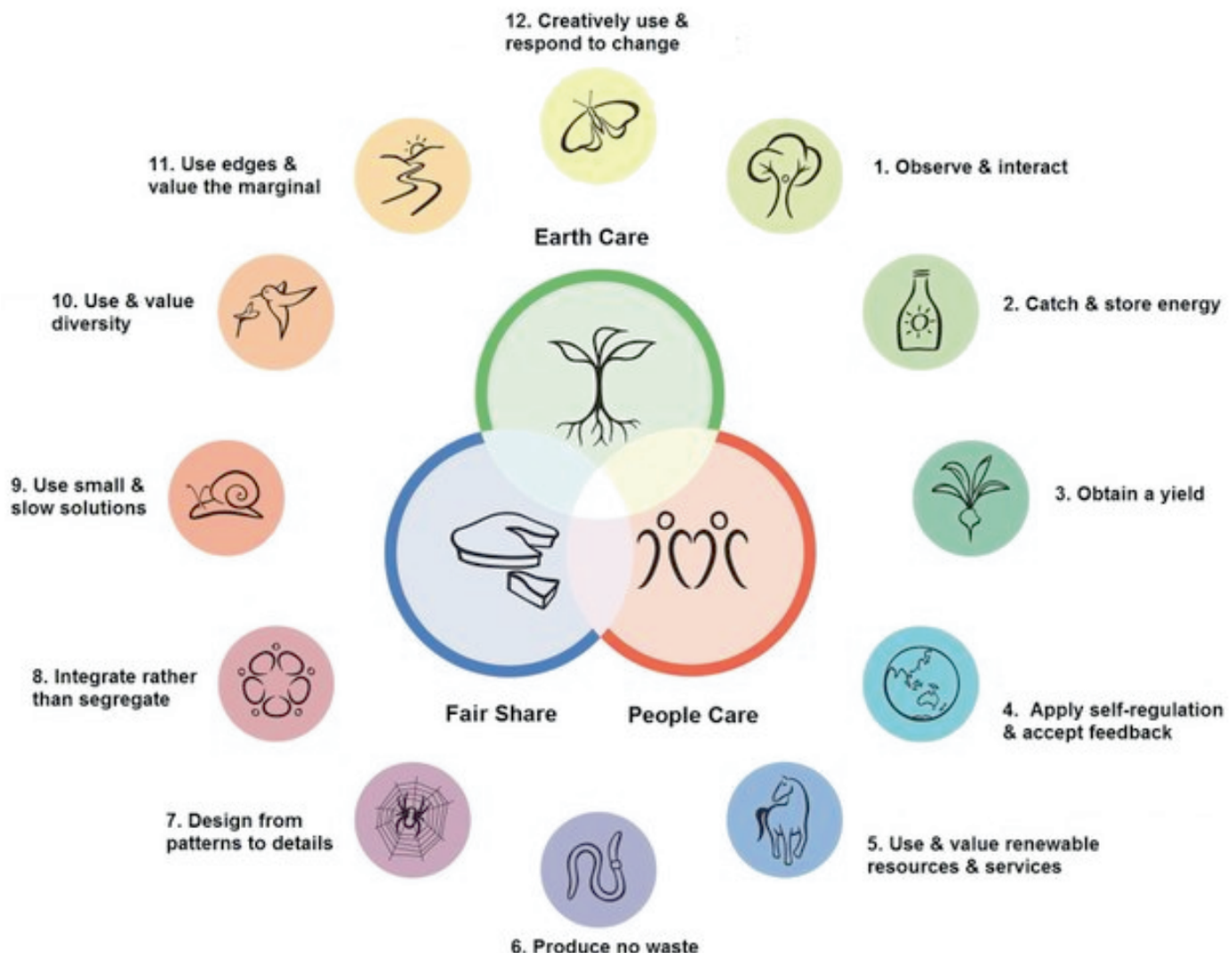
Permaculture is a process. It represents an evolution in thinking and a transition to a systems approach to problem-solving. Permaculture offers the inclusion of the core concepts of ecology into design, planning and economic rationale. Permaculture originated in the 1970's in Australia, the product of a collaboration between a forester turned ecology professor, Bill Mollison (1928-2016) and one of his students with a passion for agroforestry and perennial farming systems, David Holmgren. They checked the dictionary for a word that encapsulated their vision for a sustainable and regenerative agriculture, and tellingly there wasn't one, so they coined their own term. Permaculture is a fusion of the words 'permanence' and 'culture.' In short, it is a design system for sustainability.

Permaculture is based on these three ethics:

Earth Care: Asset stripping and resource depletion in the name of economic growth is a deficiency of imagination of the behalf of humans.

People Care: Meeting one society's needs by denying another society access to its own resources will always lead to conflict, there is an essential requirement to recognise the needs of all societal groups.

Fairshare: We can only achieve the above by recognising the idea of 'enough.' Once we have met our own essential needs, the surplus must be reinvested to enable other societies, as well as the Earth's living systems, to meet their needs.



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There are twelve principles of permaculture, the first set of six are derived from observations of nature and the tenets of ecology, if we are to behave in a sustainable way, then ecology must guide and define our behaviours. The second six show us how to achieve these goals using design principles derived from natural observations. It is these principles that form the basis of our twelve unit scheme of work. Making use of wide-ranging design tools, coupled with insights from the scientific method, permaculture challenges the student to action - to turn aspirations into a strategy, and ambition into outcomes.

Its method concurs with mainstream design, but frames it differently by making action a subset of the other two core components. Permaculture is about taking actions in a way that steers the designer onto a sustainable path.

We believe that by working together with your school - and all schools - we can make a difference to the lives of the next generation - those who will make the decisions that shape our collective future.

We can solve our collective challenge with 'One School One Planet.'

If you want to find out more about how you can get involved, please get in touch:

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Each of the twelve units contain activities and case studies that can be used to stimulate thinking about responses to climate change in a wide variety of subject areas across the school curriculum.

To make it easier to select activities and case studies for your subject area we have used the following icons and colour codes.

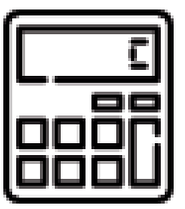
Colour Code

Activity

Case Study

Example

Summary

Icon	Subject
	Science and Technology
	Literacy
	Numeracy
	Humanities
	Languages
	Creative Arts
	Health & Wellbeing
	Geography

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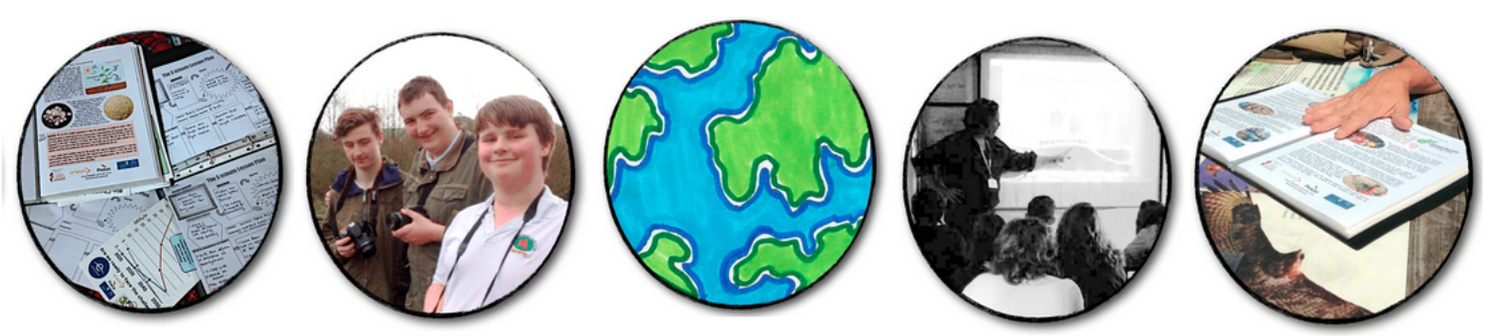


Unit 1:
Creatively Use and Respond to Change

"Don't see things as they are, but as they will be."

Thinking About Change

Each of the twelve principles covered by these units is symbolised by an iconic image, typically the image used to represent a transformative change is the butterfly, as when it retreats into its chrysalis it doesn't just sprout wings, it totally reorders its cells into a whole new version of itself!

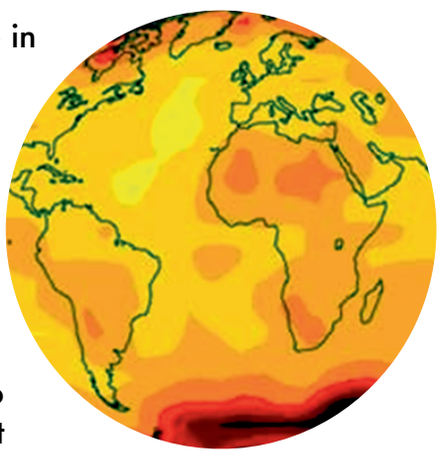
We have chosen the image of a dragonfly to represent the same idea.

The one thing that life guarantees us is change. We are challenged to see this as a creative force to be embraced. We cannot control change, but we can embrace it and shape its forces to our advantage if we are both informed and willing to accept it as a positive creative force. What do you think this means? How could we go about doing this?

Activity Making use of drawing, photography, or imaging software, create your own representative icon for transformational change. Think about the meaning of the words 'transformation' and 'change,' maybe look them up in the dictionary, or on the internet. How would you get these ideas across in a single vibrant image? What symbols or imagery would you use?

The key themes in this unit are Economic and Cultural change.

The climate is changing. This change is due in large part to the over reliance of industrialised nations on fossil fuels, and their ongoing destruction of the natural world for financial profit. This environmental destruction stems from a particular economic ideology - one that consumes environmental capital as if it were income, and externalises production and waste disposal costs onto the natural world. These activities are not without consequences. Another big change is needed!



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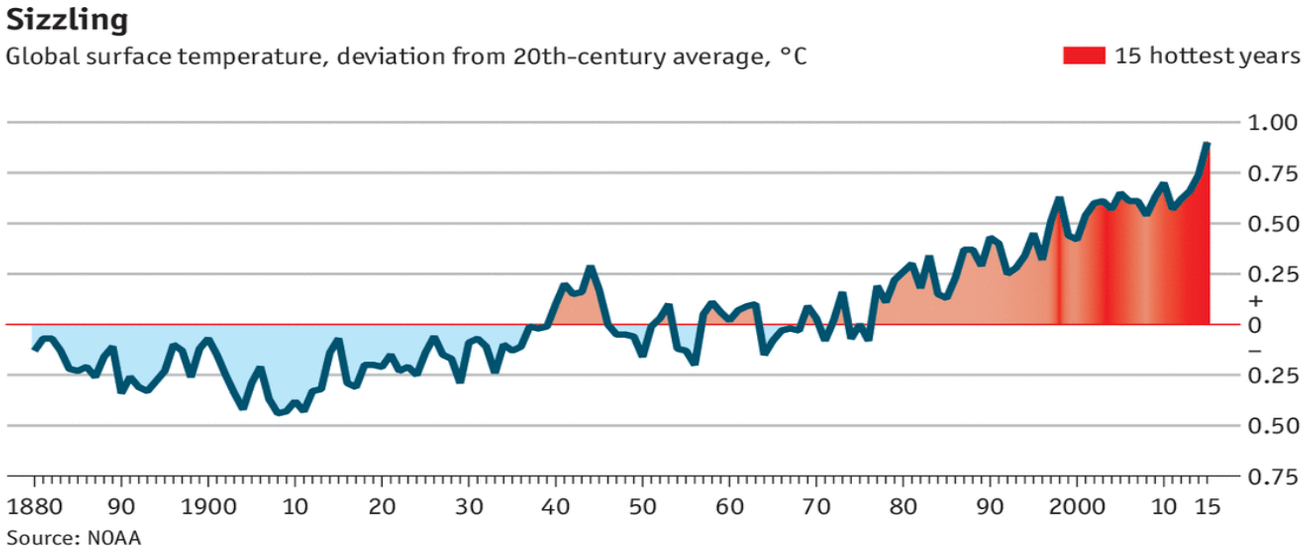
Activity Watch the twenty minute animated film 'The Story of Stuff' on YouTube. The film explains the linear nature of the consumer economy and the need to move toward a more circular economic system. Make notes as you watch, then write a short article (100 words) for your local newspaper explaining the key themes raised by the film. Think about the simplest most straight forward way to get these ideas across to your local community?

https://www.youtube.com/watch?v=9GorqroigqM

Climate Change

Scientists have anticipated climate problems from carbon fuel burning for well over a century. The tendency, however, has been to put off worrying about this effect until sometime in the future. That time is now here!

The global community, after twenty years of discussion, has finally agreed on an outline plan of action. It commences in earnest in 2020, giving us a scant two years to plan for a thirty year period of concerted action to reduce the risk of this serious problem turning into a major catastrophe. Scientists across the planet have identified an alarming warming trend which will lead to devastating consequences if left unchecked.



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This trend is referred to as Global Warming, this is because the rising proportion of carbon dioxide in the air traps heat in the atmosphere, which is increasing average surface temperatures at rates faster than observed in all geological history. This increased heat causes the global climate to change - more heat means more energy, so we can expect bigger storms and heavier rainfall, for example.

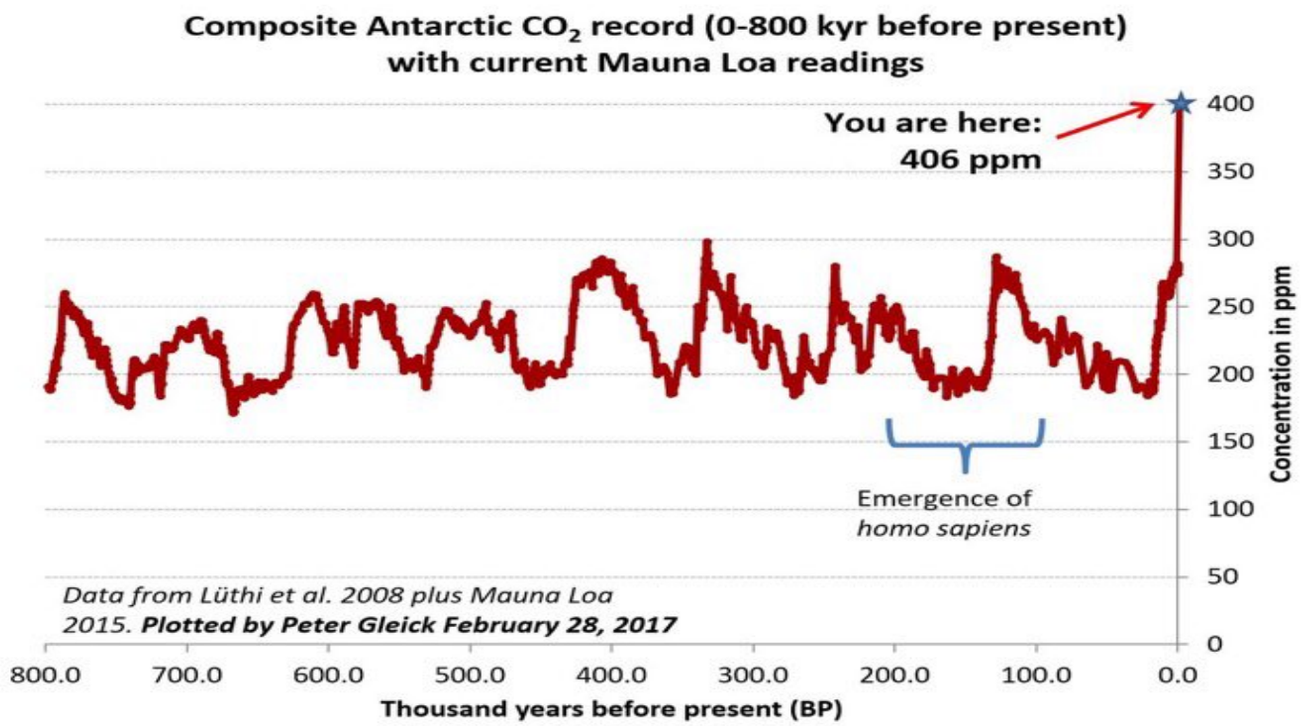
These changes in weather patterns will also cause other areas of the planet to experience drought, colder periods for some as well as much hotter ones for others. This process has already begun, and can be observed right across the globe, from disastrous flooding in parts of the UK to catastrophic droughts in East Africa.

All nations have observed these changes and scientists across the world have formed a panel to study them and make recommendations. The Intergovernmental Panel on Climate Change (IPCC) is the biggest union of scientists the world has ever seen.

Activity Find out more about the IPCC using the internet. What is it, and what does it do? How does it work? This project wants to create the biggest union of students to respond to challenge of climate change, like a student IPCC. In groups, come up with a plan for this student organisation. What would you call it? How would you organise it, and get people involved? What would your logo look like? What sort of media would you use to advertise your organisation? Once all groups have finished the plan for their student organisation, present your proposal to the rest of the class explaining all the reasons for the choices you have made. Students can then choose which name and logo they would like to use, and incorporate elements of each presentation into a final plan.

ipcc

This graph - produced from geological data from cores of ancient Antarctic ice, as well as from atmospheric data from the Hawaiian islands in the Pacific - shows that carbon dioxide levels in the atmosphere have always fluctuated because of a wide variety of natural geological factors. The problem is that CO2 has never been anywhere near current levels. Since humans began burning fossil fuels after the Industrial Revolution the amounts of CO2 in the atmosphere have literally gone off the graph. Left unchecked this will quickly become a very big problem, and we need to respond to it with urgency.



We have all been called to act on this! Facing up to this challenge will take the world thirty years of hard work, but it will also be a period of intense creativity. We are calling on thinkers, writers, artists, scientists, gardeners, farmers, teachers - literally all walks of life - to embrace this change and use their personal creativity to help us all rise to the challenge. It is up to us to creatively transform the challenge of climate change to our global ecological advantage.

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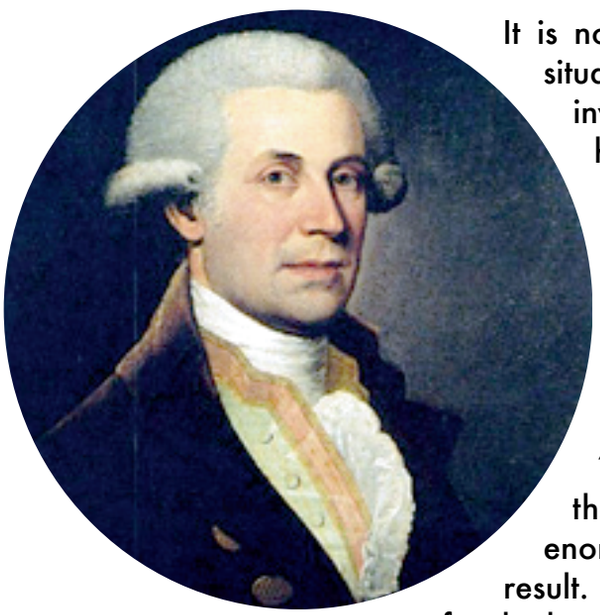
No Cause for Alarm, the Problem is the Solution!

You could be forgiven for finding all of this a little bit frightening. A failure for the world to act on this and to make the changes necessary will almost inevitably bring about unimaginable destruction. We simply won't be able to carry on living as we are used to. The biology of the planet - which produces our clean air, water, food and habitats - will simply break down into something unrecognisable.

These scary and very real threats, however, will only become a reality if we collectively fail to act. That is why the world has come to together to work out courses of action that will avert the worst of this crisis and will create new and better alternatives for us all. In fact, fixing this big climate problem will also help us fix thousands of other smaller social and economic problems at the same time - it will create new jobs, livelihoods and real meaning and purpose for the next three generations, and that means you too!

You and your generation literally get to save the world!

No Blame Game



It is not helpful to seek people to blame for our current situation. In 1709, when Abraham Darby I (1678-1717) invented the first blast furnace in Telford, Shropshire, he had no idea about the impact burning coal and limestone to produce iron and steel would have on the world 250 years later.

Steel making quickly moved from landlocked Shropshire to South Wales, to Cardiff and Swansea, which quickly became the most important industrial cities in the world at the time. In 1830 over 90% of all the iron and steel produced in the world had been made in South Wales, and enormous wealth and economic progress came as a result. Perhaps unsurprisingly this was perceived as change for the better.

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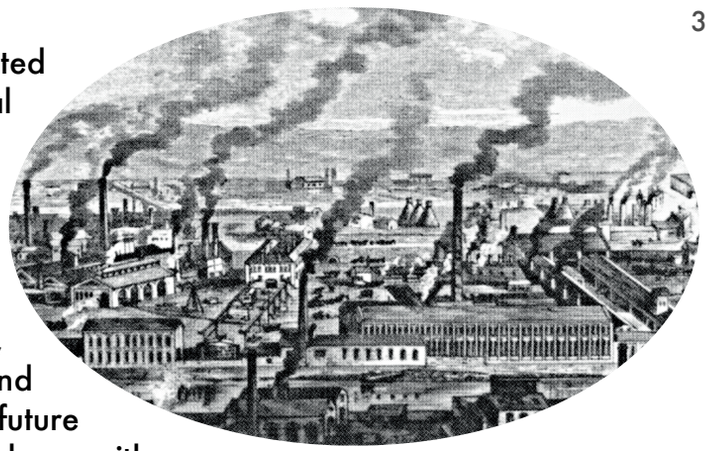

Quite early on certain scientists had started to wonder what impact all of this coal burning might have on the planet. They realised that the fumes, smoke and smog would in some way change the atmosphere, but they didn't quite know how. Additionally, the world seemed so big at the time, and industry so small, that all concerns were put aside and people generally assumed that in the future our science and technology would provide us with easy solutions, if such a problem did indeed exist. We also have to remember that scientists back then didn't have the necessary tools to measure such changes, there were no satellites, no internet, and very little funding. Besides, too much wealth was being created with these new technologies for anyone to really worry about the long term effects.

There Are No Excuses Anymore

We can be generous in forgiving our ancestors for not realising the impact of their work on the global climate. In many ways they created the tools and technologies we now enjoy in the modern age - our cars, computers, agricultural technologies, modern drugs and pharmaceuticals, all of which are made from and reliant upon the coal, gas and oil we began using at the dawn of the industrial age, and that are now fuelling climate change.

But, we now have the resources and tools to measure the impacts we are making in great detail. We also have the technologies to enable to us to continue to live modern technological life without continuing to burn fossil fuels at the currently alarming rates that we do. As if the climate problem wasn't enough, these fossil fuels, which we mine and pump from deep within the Earth's core, are becoming increasingly hard to find and so are also very costly to extract. This resource depletion is fuelling wars and conflicts around the globe as countries compete for access to the remaining economically recoverable reserves. Change is needed!

Everybody knows we have to change, but somehow we are finding it hard to really commit to the changes we have too make. Sadly, every day we fail to make these changes we make life a little bit harder for the coming generations.

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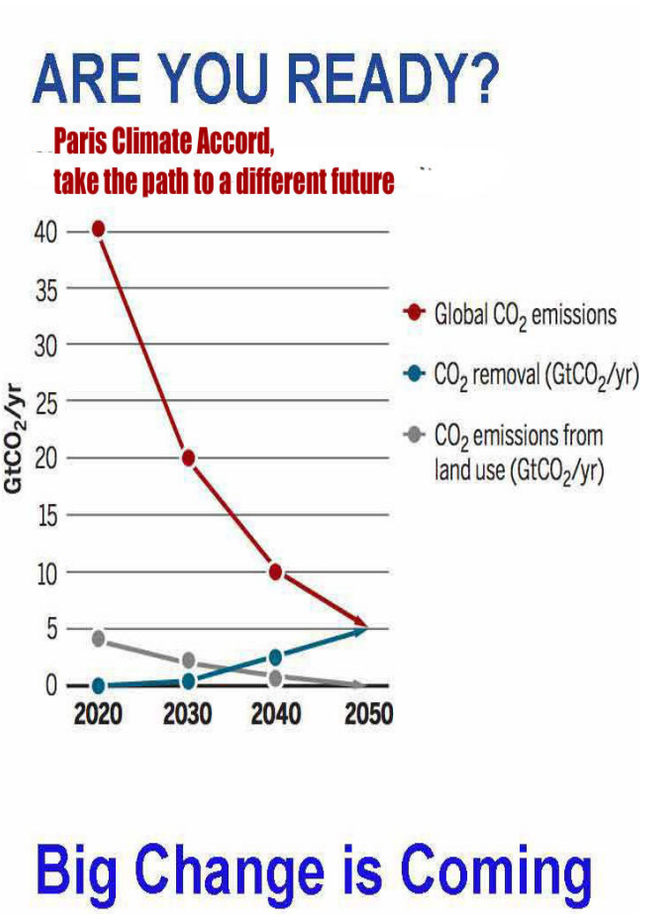
The Paris Agreement is essentially our road map to the future, if we can follow what it asks of us then we have every chance of avoiding the worst consequences of global warming and the resulting climate change.

The Paris Agreement gives us all just two years to make some plans, to think about where we are going to start, and to decide how we are going to face this challenge. By the time we get to 2020, however, we are all required to start putting these plans into action. We don't have much time to get prepared!

Governments and businesses, of course, will have to lead the way, but in reality they don't like facing up to change either. Furthermore, their ideas of how to solve these problems only go so far, and will often serve their own financial ends. It really is up to all of us to understand this challenge better and find way to respond in our own lives, in our schools, at work, in our communities and in virtually all aspects of our lives.



Activity What changes could you make in your life, in your school and wider community, to help us to meet the requirements of the Paris Climate Agreement? What could you do to help reduce carbon dioxide emissions? How would things like travel, agriculture and shopping have to change to meet these requirements? Think about these ideas in groups and then report back to the rest of the class. It would be great to come up with a list of creative solutions that could be presented to the senior leadership of your school.

Communicating Change

To say that the advancement of climate science into the public arena has been controversial is an understatement. As the debate over global warming has grown so too have the attempts of the oil industry and related businesses to confuse the agenda with 'bad science' misinformation and outright lies.

Even the current Trump led USA administration claims not to believe in climate change. Science, however, is sceptical by nature. In order to meet modern scientific standards, new theories must be backed up with evidence, which must be checked and re-checked by other scientists in a process called peer-review. The climate change data has passed through this rigorous process.

The scientific community is more certain about climate change than just about anything else. The body of evidence is overwhelming and still growing. The only debate that remains is just how bad it is and how urgent is the need for concerted action.

The climate science website www.skepticalscience.com is written by scientists using common every day language. Many common mis-held views about climate science are dismantled here with proper evidence based discussion. If you need to check any facts or arguments then this is the place to go.

Activity In today's busy world, and especially since the advent of social media, we are constantly inundated with messages competing for our attention. Because of this science has had to find new ways to communicate its complex ideas in an increasingly crowded media space. Memes are one example of this new form of science communication. They pack a lot of information into a small space. Create your own memes about the importance of facing up to the challenge of climate

Summary

What is your vision for the future? How do you see the world in 2050? Did we manage to face up to the challenge of climate change? If so, how? Write a newspaper article from the future explaining the changes that we had to make.

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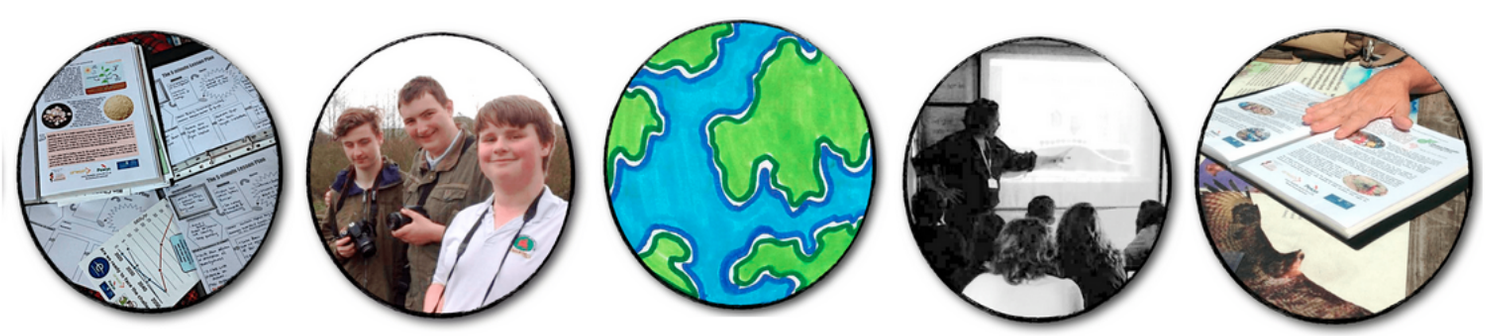

Unit 2:
Observation

"Beauty is in the Eye of the Beholder."

Turning Problems into Solutions

Following on from the idea of change as a constant force, we must ask ourselves a fundamental question: how do we deal with change?

This is a key question to ask! There are a great many looming problems in the world, and permaculture design puts forward the powerful idea that a problem and a solution are the inverse of each other.

What do you think this means?

The way to resolve any problem is through protracted and thoughtful observation. Often when we might think we are tackling a problem we are in fact only dealing with a symptom of the problem, rather than the cause, and this can lead to much wasted energy.

Activity Suggest some world problems that you are currently aware of. We have already talked about climate change as a global problem. Perhaps you can think of some other global problems? You could also include local problems, or even problems that directly affect you personally. How would you go about trying to solve these problems? What steps would you take?

Examples of global, local and personal problems:

Deforestation, top soil loss, rising food prices, world population, competition for resources, pollution, war, social deprivation, lack of jobs, discrimination against race, gender, religious or sexual orientation, litter, dog mess, lack of access to land, lack of economic opportunity, lack of money, fitness, health, exercise, good education, etc...

Which of these worries you the most, and why?

Can you add anything more to the list?

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The Story of Chikukwa

Chikukwa is a community living in a remote valley called Chimanimani in Zimbabwe. As a result of over grazing, the community was suffering horribly from malnutrition. This was caused by the fact that their farming system didn't work for the kind of land they were living on.

One hundred years previously, Colonial British farmers had pushed them from their traditional lands onto much steeper marginal land. For a while they were able to cope quite well, until deforestation, overgrazing and soil erosion destroyed their land and traditional ways of life.

Seasonal heavy rainfalls - when they did come - caused huge damage. Instead of moistening the soils and replenishing wells, the rain washed away unprotected soils, created erosion gulleys, and left behind a devastated landscape. Wells dried up as ground water was not being replenished, and the community of some 7,000 people was very soon on the brink of collapse. Why do you think this happened? What could have been done to prevent it?

Activity Research the rainfall statistics for Zimbabwe and compare with the UK. How and why are they different?

This is Chikukwa valley in 1992. You can see how all the trees on the upper slopes have been cut down for fuel and they have not regrown because of grazing by cattle and goats. There is bare soil everywhere, drying our and eroding. Rainfall flows over the landscape worsening the erosion, rather than nourishing the soils. The house in the bottom of the picture is the home of one of the initiators of the project to rejuvenate the valley. His wells began to dry up in the dry season, which made him worried about the future. He knew something had to change.

Solving Problems in Chikukwa

Faced with this terrible problem members of the community began to have meetings to try to come up with some solutions. A small group of the villagers had heard about permaculture design as a way to solve problems so they sought advice from a tiny permaculture training centre called Famidzanai in the capital city Harare.

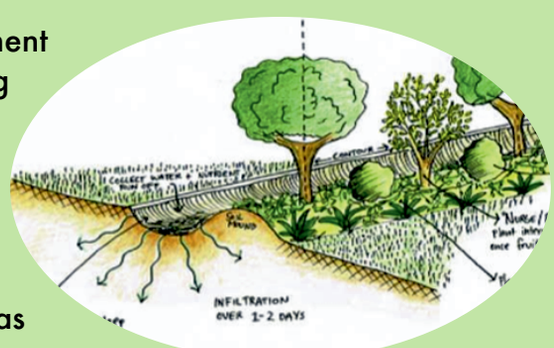
They made many observations and began to understand that in order to solve their problem they would have to make many changes to the way they were managing the landscape. They would have to learn to see it in a completely different way and change their farming practices. Here are some of the ideas the villagers came up with to tackle the damage that had been done to their local environment.

* Instead of allowing their cattle to graze the high steep slopes they decided to replant them with trees to make a forest. This will protect soils and help trap rainfall and prevent erosion.

* All goats must be tethered. Farmers were in the habit of letting their goats roam around and graze on wild vegetation. This caused many problems when they tried to replant to protect the damaged soils. It took much discussion before people could agree that this was the right thing to do.

* Through observation the villagers realised that trees and shrubs, when planted along contours, also help to slow down surface flow and make water infiltrate into the ground. They chose to plant trees and shrubs that help fix nitrogen in the soil. They do this via root associations with soil bacteria, it is a complicated process but over time the soil becomes more fertile and better able to absorb and hold onto water when it rains.

* Pioneer groups of villagers decided to implement a system called swales. This involved mapping the terrain to find the contour lines and then to dig ditches and banks along the level lines, to stop rainwater from escaping and eroding the land during the rainy season. This was extremely hard work, and some villagers thought the people doing this work were mad as there was no immediately visible benefit.



Solving Problems in Chikukwa

Here you can see miles of swales that the villagers have dug. This work took many back breaking days, weeks and months, but gradually the land began to change. Slowly more people became interested in what the pioneers where doing and soon large groups of people heading up the hills each day to dig more swales. They sang songs as they worked and a strong feeling of camaraderie started to grow between them.

* Compost is a key technology. One of the biggest changes for the villagers was to learn to value natural resources much more than they had previously. Having to repair the damaged landscape, being poor farmers on the verge of malnutrition, they learned to value what they had much more. They learned to combine animal manure, dead plant matter, food scraps and peelings together through composting to create stable and fertile soil additives, which in turn made it much easier to grow more plants to further stabilise the landscape, to cover and protect bare soils, to feed to grazing animals, and also to make more compost!

* Here is a Chikukwa farmer, lets call him John Chisango. It is now some years into the project. Notice his swale is stabilised with fast growing elephant grass, a fast growing deep rooted fodder plant that secures the soil, he cuts it regularly to feed to his cattle. He collects the animal manure and composts it together with food scraps, leaves and other plant matter to enrich his soils. He has learned to always keep his soil covered and protected with either crops or green manure plants, ones grown for the benefit of the soil and soil life. Notice the shrubs growing in front of his house, these are nitrogen fixers, part of the legume family, he feeds the seeds to his chickens and the leaves to his carefully tethered goats, collecting the manure for his compost heaps. As well as growing traditional staple crops like maize he has diversified to produce tree crops also, like avocados, guavas, oranges, and papayas. These long term crops take a few years to develop but once established become a reliable addition to his annual crops. The trees also provide shade, habitat for birds which also help regulate pests such as insects.

Making it Work

This is the same landscape in 2014, 22 years later. What had been a huge problem has now been turned around. The upper slopes are now covered in forest and are out of bounds for grazing animals. Swales and contour plantings have stabilised the soils, and the leguminous shrubs, trees and compost use has boosted soil fertility. Tree crops add to the farmer's yield and provide shelter from the elements, as well as a diversity of other yields for the community. Many more families have joined the scheme now, and thousands of farmers are learning from the Chikukwa pioneers.

It is now regarded as one of the most successful projects in Africa and what is interesting to note is that it was not an AID, development or government project, but one that was initiated by the community itself using local resources and developing the skills they needed as they progressed. Key to this success were regular meetings and good communications. Not every idea they tried worked first time and some people were resistant to the many changes that were happening. As the work progressed many meetings were held to discuss plans. They talked about what had been learned, what was working well, what was most challenging, and what changes did they need to make to improve on the progress? They have demonstrated what can be achieved by problem solving using observation; by working together and

Activity Look up the work of Hub Africa Cymru. Good communication between countries is essential to finding solutions to world problems. How is this organisation helping to develop strong links between Wales and Uganda?

Summary

In your own words, explain how active observation of the landscape and natural principles helped the people of Chikukwa to overcome their climate challenge.

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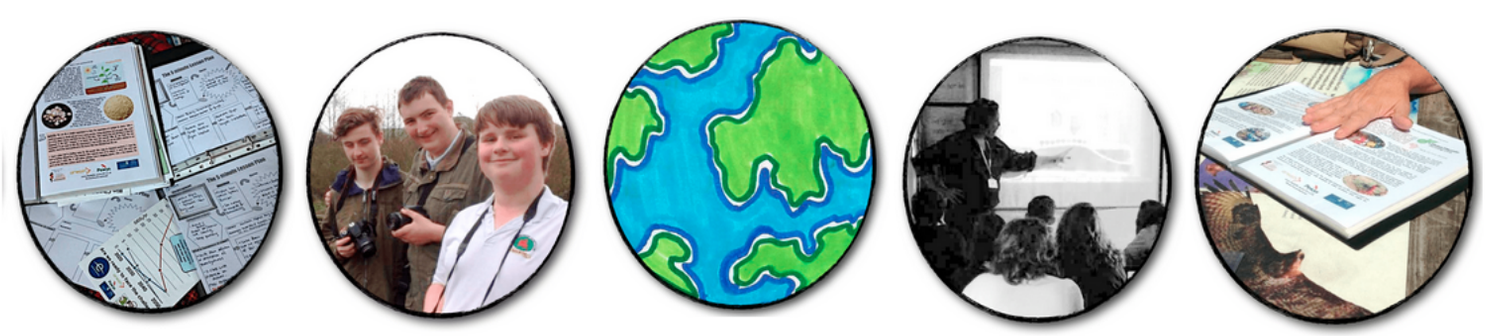


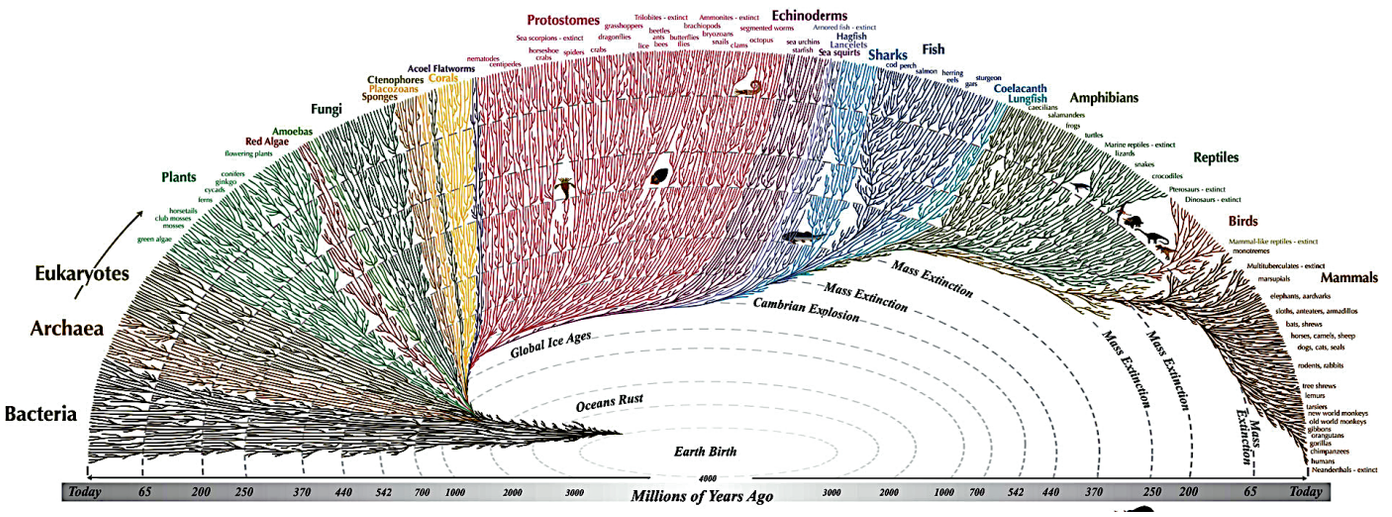
Unit 3:
Catch and Store Energy

"Make Hay While the Sun Shines."

Life and Energy

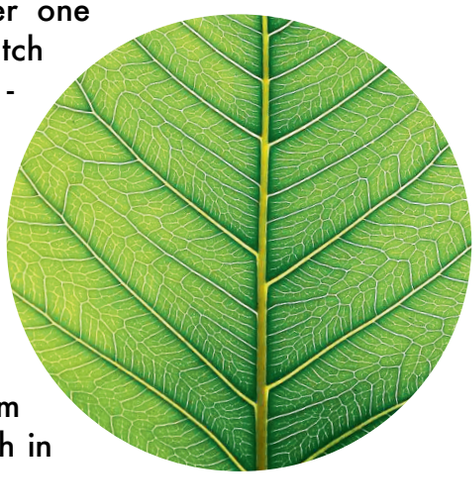
All life requires energy. The earliest forms of life on Earth were simple organisms made of one cell only. They used geothermal heat from the Earth's crust to perform very simple chemical reactions. Life at the dawn of Planet Earth was characterised by such simple organisms, but once it was established it evolved rapidly, giving rise to the huge variety of lifeforms we see today. The Earth became increasingly bio-diverse with time.

Have a look at the graphic below. What does it show?



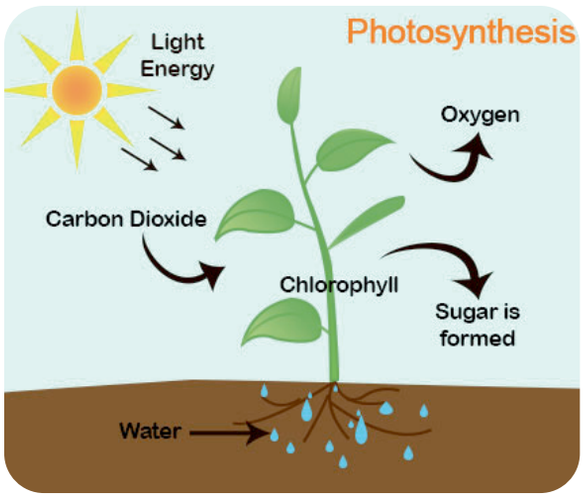
This image represents the evolution and genetic origins of the Earth's current biodiversity. It shows that all life on Earth has a common origin, and that many more species have evolved than have gone extinct.

A really important evolutionary step - which occurred over one billion years ago - was for organisms to learn how to catch energy from the sun and turn it into a stored form of energy - sugar. Plants are the masters of this and they have a strategy for catching the sun's energy that is so good that all other lifeforms have come to depend on plants, either directly or indirectly, for their energy.



We humans are no different. All the energy we use today comes from plants, all our food is derived from plants - grasses, roots, tubers, seeds - all stored forms of energy from plants, or it is animal in origin - beef, lamb or chicken - which in turn have derived their energy from eating plant material.

Plants have an amazing ability that sets them apart from all other life forms - they can photosynthesise. This means they have special cells in their leaves called chloroplasts, which contain a pigment called chlorophyll. Chlorophyll captures the energy of the sun and combines it with water and carbon molecules from the air to produce glucose (sugar), it is also what makes most plants green! It is worth noting that plants also give off six oxygen molecules and six water molecules as by-products of photosynthesis. This is very useful for us mammals, as we need oxygen and water to survive.

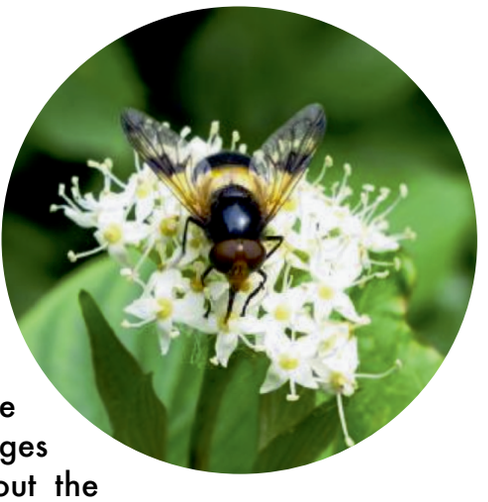


The sugar molecules combine together to create carbohydrates in the form of starch, and most plant energy stores are made up of this incredible compound. Potatoes, rice and wheat are good examples of plants high in carbohydrate stores. Chips and bread are full of carbohydrates, and this is what gives us the energy we need to live our lives. We all need energy to survive!

Activity We can do a simple experiment to show the importance of sunlight for plants. Take a small houseplant or shrub and put it in a sunny position. Using aluminium foil and paper clips, cover one of the plant's leaves and leave for four to five days. Then, remove the foil and observe what has happened to the leaf. Compare it to leaves that were not covered. Why do you think this has happened? If you want to take the experiment a step further you can use an iodine solution to see whether starch has been produced in the leaves that were blocked from the sun:

1. heat a plant leaf in boiling water for 30 seconds (this stops its chemical reactions), 2. heat the leaf in boiling ethanol for a few minutes (this removes most of its colour), 3. wash with water and spread onto a white tile, 4. add iodine solution from a dropping pipette, after a few minutes, the parts of the leaf that contain starch turn blue-black.

Exchanging Energy



Plants also make use of sugars - this time in the form of nectar - to entice other organisms to work for them. Here is a hoverfly enjoying the sugary nectar from a flower. In return, the hoverfly will carry pollen grains to other plants, thus enabling seeds to be produced. It is a very clever and efficient exchange based on energy.

When we study the natural world we slowly come to realise that all life is a complex web of interactions and exchanges between living things. No single organism can exist without the other, and most of these crucial interactions are based on energy exchange.

'Co-operation, not competition, is the very basis of existing life systems and of future survival.'

Bill Mollison, the founder of Permaculture, observed this crucial web of interactions in his study of the world's ecosystems. In fact, 'ecology' as a branch of Biology emerged towards the end of the nineteenth century specifically to explore the relationships and interactions between organisms and their environment. Before this time naturalists and biologists had tended to study individual organisms in isolation from other organisms and their natural habitats. By ignoring the wider context, early naturalists failed to grasp the key mechanisms that have allowed life on Earth to flourish and diversify.

Catching and Storing Energy is Our First Strategy for Survival!

Activity The saying that goes with the Permaculture principle 'Catch and Store Energy' is 'Make Hay While the Sun Shines.' It reminds us that catching and storing energy is a timely and strategic action. Can you think of forms of energy that we need to catch and store? Make a list of as many forms of energy as you can think of. Remember, energy can take many different forms!

Water as Energy

Water is constantly flowing through living systems. As soon as there is a drought, or some other kind of water shortage, we are instantly reminded of just how much life depends on water. We store water in dams and reservoirs, in tanks and bottles and in moist fertile soils. All of these are strategies used to hold onto this vital resource.

In a world in which climates are rapidly changing we are reminded that we should expect periods of both shortage and deluge - in other words, droughts and floods. If we are wise we will have to prepare for this in as many ways as we can. How many different methods of water capture and storage can you come up with?

Soil is Life

If we depend on plants for our energy then we also depend on soil. Without healthy topsoil there is no possibility for life on Earth. It is vitally important that we understand just how important soil is! Those fifteen inches or so of weathered rock and decomposing organic matter are what we, and every other living creature, depend on for our survival. It would be sensible for us to think about our soil, and to value it a whole lot more than we currently do.

Activity It is probably not something you have thought about before, but what does soil mean to you? What does it make you think about? What impact does it have on your wellbeing? Write a paragraph explaining what soil means to you and why.

Soil is amazing, it is alive - full of life in fact! There is more life - more diversity and interactions of organisms - under and within the soil than what we observe above ground. In the same way plants give off sugars in the form of nectar to entice pollinating insects, they also give off sugars through their roots to entice soil organisms to work with them. Fungi, bacteria and microscopic worms exchange minerals and other nutrients with plants through their roots in return for sugars, giving them the energy they need to continue working for the plants. The more scientists study soil the more complex its biology and chemistry are found to be.

Soil is the ultimate store of energy and if we humans wish to carry on living on this planet then we will need to work with it much more carefully than we currently do. Our farming methods of ploughing - which leaves soils bare for months at a time - and use of big heavy machinery - which compacts and squeezes the air out of the soil harming soil life and causing erosion and flooding - will have to stop.

Soil is also the place where most of the carbon is stored. Too much carbon in the air in the form of carbon dioxide is what is driving climate change. More carbon in the soil makes it more fertile and better able to store water. What we need, then, are methods of capturing carbon and storing it in the soil where it belongs.

Composting and Mulching

One method of catching and storing carbon in soil is by making compost. Compost is a mixture of biodegraded organic matter and living micro-organisms. When added to the soil, compost boosts fertility by adding nutrients and locking in carbon. It is very easy to make compost at home. Here, Abraham, a farmer in Kenya, can be seen carefully layering brown materials (rich in carbon) with green materials (rich in nitrogen) and moistening it with water to kick start the compositing process. Abraham is catching energy from waste materials and storing it in the soil.

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Another simple way of catching and storing energy in the soil (this time in the form of water, nutrients and carbon), is through mulching. In nature, soil is very rarely left bare and open to the elements - it is usually covered with vegetation of one form or another, which forms a blanket of protection for the soil below. Making use of this observation, we can emulate nature and cover our soil to protect it too. Mulching involves covering the soil with organic matter to form a blanket - you could use leaves, wood-chip, straw or even cardboard to do this. The mulch protects the soil from the sun, preventing the evaporation of moisture. In heavy rain the mulch absorbs water and helps to prevent soil erosion. As it bio-degrades, carbon and nutrients are added back into the soil, making it more fertile.

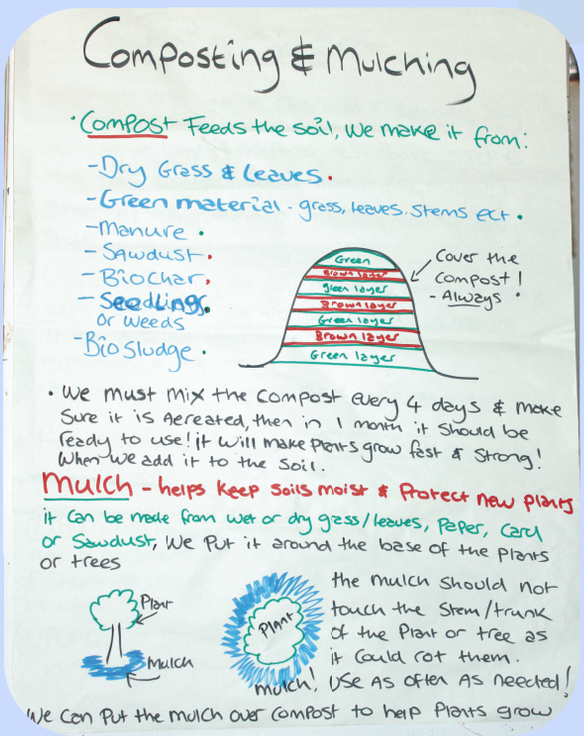
Activity Watch this 7 minute video clip. It demonstrates just how important it is to keep soil covered with mulch material. Can you replicate the experiment with soil gathered from your school? Are there any areas in your school that would benefit from being covered over with mulch? Here's the link: https://www.youtube.com/watch?v=og9cQKxlFnE

Summary

This poster was produced on a permaculture design course in Uganda in 2017. It clearly shows the steps and ingredients needed to successfully make compost and the benefits of mulching.

In groups, create your own posters to demonstrate how composting and mulching can benefit our soil and the plants and animals that live in it.

Composting and mulching are closely connected with the theme of the next unit - 'Obtain a Yield.' In what way?



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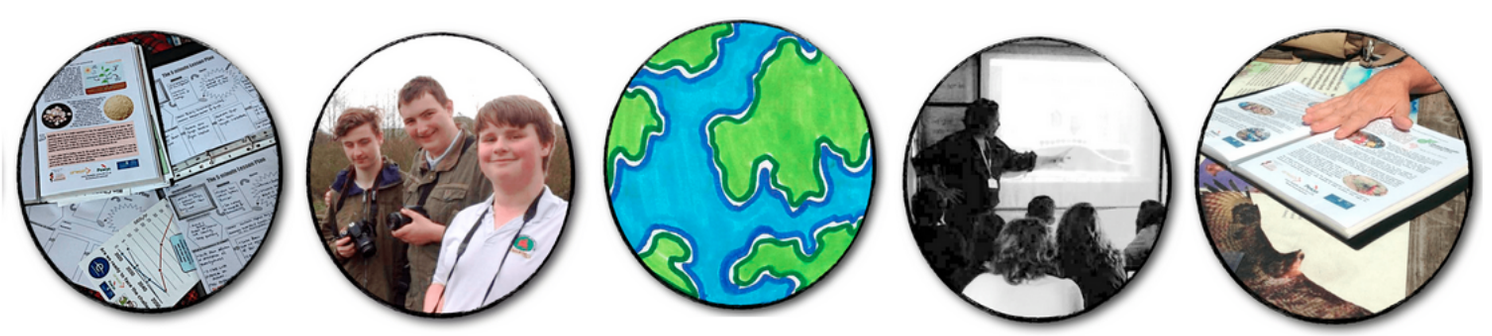


Unit 4:
Yields

"You can't work on an empty stomach."

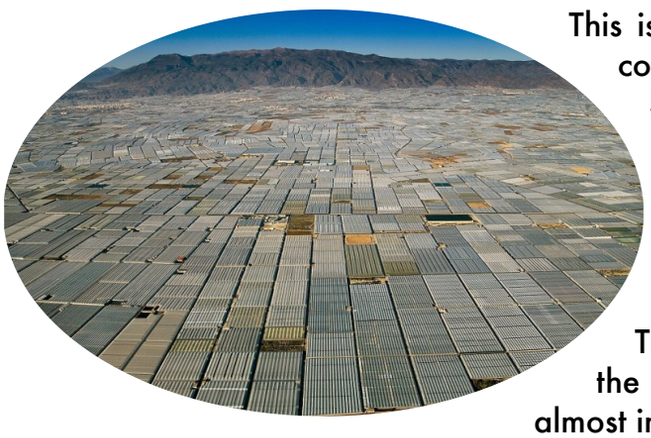
Obtain a Yield

Nature doesn't just catch and store energy in all its forms, it also creates yields. Every part of a system has to be fed for that system to continue. In the West we have become very detached from our food producing systems. Our food seems to 'miraculously' arrive in the shops, often processed to such an extent that we can no longer recognise where it has come from, or how it was made.

In UK we are fed by the world through a complex delivery system that is wholly reliant on petroleum fuelled transport and communications, and highly complex computerised payment systems. The hard fact that we have to face is this - the food on our plates, delivered by a globalised food system, consumes enormous amounts of energy in terms of the diesel, petroleum and petrochemical fertilisers and pesticides that went into producing it. Add to that the processing, storage, packaging and waste collection, it is easy to understand how it is possible for there to be 10 calories of oil energy for every calorie of food we eat.

This is not sustainable!

Activity Take a look at the labels on food in the supermarket next time you are there. Make a note of where the ingredients in your food come from. What is the furthest distance your food has travelled?



This is where most of the UK's vegetables currently come from. These greenhouses are in the South of Spain - an arid region - and they are grown using ground-water pumped from many metres below the surface. Many of the workers are migrants from North Africa working for very low pay, and the produced is trucked and flown 2000 km to the UK in refrigerated units. The energy cost is high, and any disruptions in the supply chain would mean we would have almost immediate fresh food shortages in the UK.

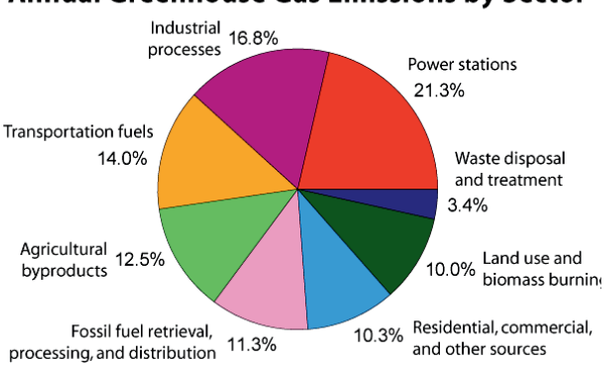
This is the Garth Organic garden in in Glyn Ceiriog, Mid-Wales. It is run mainly by volunteers and is supported by very small amounts of funding. It produces fresh vegetables and fruits all year round for local consumption. All production is organic, they grow green manures and make compost to keep the soil fertile. They also offer support and training for new growers keen to learn skills, and carefully monitor wildlife and biodiversity - which continues to increase every year that they continue their work.

Activity Discuss and record your thoughts on the relative strengths and weaknesses of the two food production systems discussed above. How might issues such as climate change and declining oil reserves affect the two systems in the future?

No Bare Soil

Farming is the source of 5 giga tons of carbon dioxide. According to the Paris Climate agreement over the next 30 years it has to move from being one of the largest sources of carbon entering the atmosphere to being one of the main ways we remove excess carbon from the atmosphere. As we have already seen, by returning carbon to the soils it becomes and asset rather than a problem.

Annual Greenhouse Gas Emissions by Sector



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One of the main problems is ploughing. Large scale farmers regularly plough the soils to turn in weeds, bring up nutrients from deeper down in the soils, and to prepare the land for new crops. The problem is that in nature such a thing would never happen. Our rich soils formed under the cover of a permanent forest canopy, or beneath pasture. In nature soils are never exposed to the sun, wind and rain except on very rare and exceptional occasions.

When might you find bare, exposed soil like in a ploughed field in a nature? How many ideas can you come up with?

Natural causes for bare soil:

* Large tree falling
* Landslide
* Flood
* Fire
* Animal digging...

{ These are all things that would only ever happen very occasionally and the soil would be quickly covered by wild plants to covered up again to minimise damage.

When precious soils are exposed to the sun the carbon - from dead plant matter, soil organisms, and so on - oxidises. That means it combines with the oxygen in the atmosphere to create carbon dioxide - the very thing that causes climate change.

Organic growing systems are always centred around returning carbon back to the soil - e.g. with manure, compost, green manures - and are usually concerned with keeping the soil covered with crops, tree cover, and dead organic matter (mulch).

This constant loss of carbon means that fertility and water retention are always decreasing, which is often compensated for by adding fertilisers (made from natural gas), and irrigation - pumping water using diesel powered pumps. Farming practices are going to have to change radically in the coming three decades! There is much scope for innovation and problem solving.

Activity Research the carbon cycle. What is it? How does it relate to climate change?

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Permaculture design suggests that a significant proportion of food production will have to be relocalised, and that families, schools and whole communities would be wise to begin to produce at least some of their fresh fruit and vegetables. By making simple changes, like keeping chickens for free range eggs, farming fresh water fish, and cultivating and growing mushrooms, we can create a more climate friendly - and so also more climate resilient - food system that can also help us reduce carbon emissions and help fight climate change.

Examples of community responses might include:

* More allotments and home and family gardens.
* Community supported agriculture schemes, where the public develop close relationships with local farmers to produce affordable and local organic foods.
* Community food growing spaces, where orchards and small scale field production happens in public and shared spaces, managed by professional growers but with most of the work carried out voluntarily in return for food.
* School gardens, where student work with teachers and professional growers to produce and process fresh produce for school and local consumption as part of enterprise and skills training schemes.

Here we can see pupils at Sabina School in Rakai, Uganda in their school garden, where they study agriculture and permaculture and produce high quality organic fruit and veg for the school kitchen. This keeps the price of school fees down and guarantees them high quality produce to eat every day. They are growing Bananas, Pumpkins, Mangoes and Avocados.

Activity What would you choose to grow at school if you had the opportunity? Think about what sort of plants would thrive in the grounds of your school, and about how useful they would be for the school community. What would be the benefits of having a school garden?

Sabina School, Rakai, Uganda

Here are some of the 13/14 year old students from Sabina School with avocados from their school garden as well as a tray of seeds they have collected to grow more plants for next season.

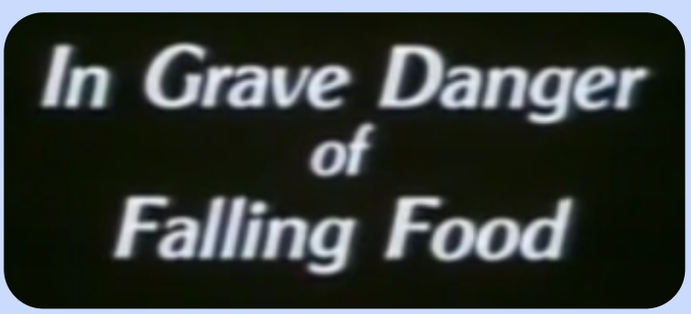
Sabina School has joined the #OneSchoolOnePlanet scheme and they are keen to share their stories and ideas with you. Many of the students have Facebook pages, they use What's App, and have a website and blog.

Why not share some of your ideas and discussion with them? Or, ask them questions about their gardening experiences?

"The greatest change we need to make is from consumption to production" - Bill Mollison.

Permaculture founder Bill Mollison made it very clear that our lives of consumption make us very vulnerable to changes in the climate (as well as in the economic system). An over-reliance on imported foods and petrochemical agriculture will leave us exposed to sudden changes. It also takes the pleasure of local food growing and the community connections that come from that work away from us.

Summary



Watch this 60 minute documentary written and presented by Bill Mollison.

It was made in 1986, so is a little dated in terms of graphics and sound, but it is also somehow timeless and prescient.

Mollison's voice rings out like a clear warning that we ignore at our peril. The film is up-lifting, funny and challenging. It is certainly not to be missed!

https://www.youtube.com/watch?v=JrtJbk8_GY8

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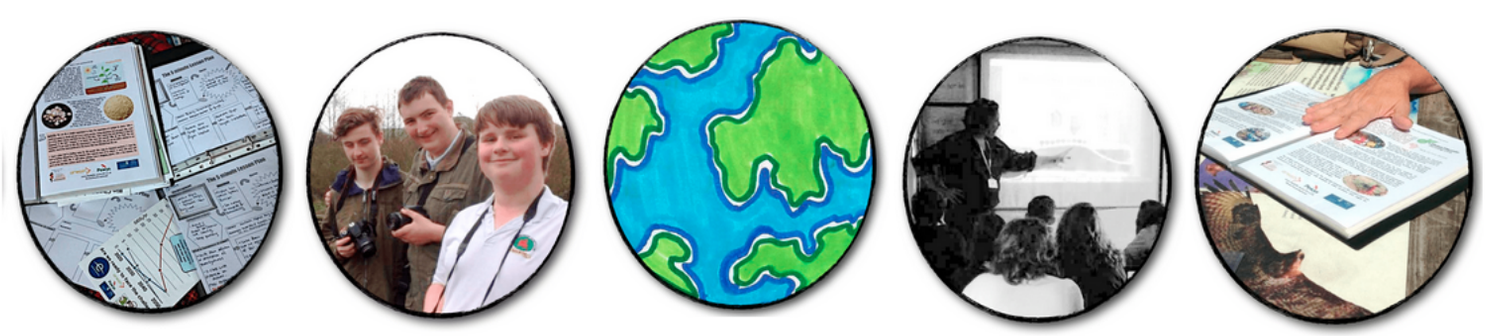
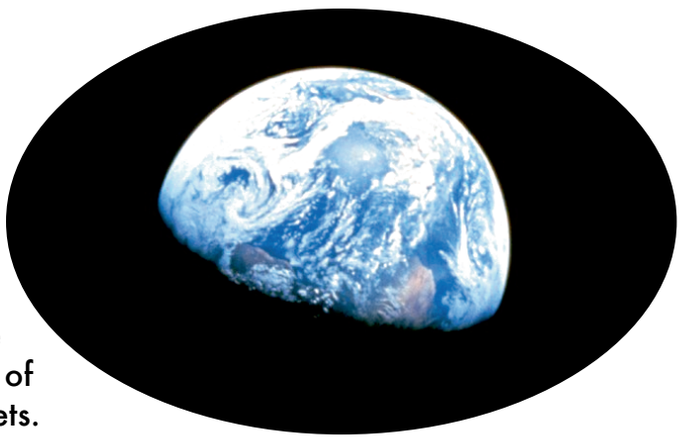


Unit 5:
Limits and Feedback

"The sins of the fathers are visited unto the seventh generation."

Limits and Feedback



Unit 5 is all about feedback.

In the 1950s and 60s - before we had even visited the moon - there was an intense fascination (as indeed there still is), about life on other planets. A British scientist called James Lovelock, who was then working for the space agency NASA, was assigned the task of working out if there might be life on other planets.

Lovelock knew that by refracting the sunlight bouncing back to Earth from the planets he could determine the chemical composition of their atmospheres. As the light travels through the gasses of another planet's atmosphere it interferes with the structure of the light beam in distinctive ways. Armed with this knowledge he and his team started studying the atmosphere of nearby planets like Mars and Venus. He asked the key question:

What would the chemical signature of life on another planet be? What do you think?

He realised that the answer is oxygen. Oxygen is the most reactive element and will react with whatever is around. It reacts with carbon to make CO2, Hydrogen to produce H20, and iron forming iron oxide FeO (better known as rust). For oxygen to be present it has to be continually produced by some means, otherwise it would all react away.

> "Oxygen is too chemically reactive to remain a free element in air without being continuously replenished by the photosynthetic action of living organisms" (Wikipedia)

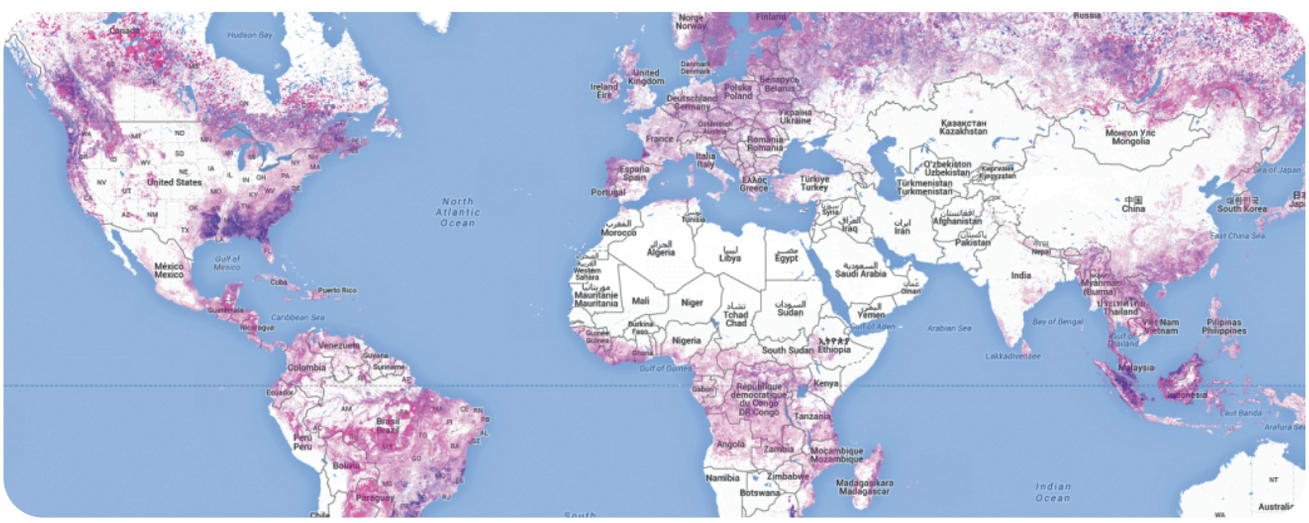
Activity Research the work of James Lovelock and write a short newspaper article (200-300 words) about 'Gaia Theory.' The article should include what 'Gaia Theory' is, how Lovelock came up with it, and how it helps us to understand our role in climate change and what we can do to face up to the challenge.

Where Did Our Oxygen Come From?

About 3.7 billion years ago when the planet was mainly shallow warm seas a new organism evolved called Stromatalites. They are still around today, but back then they were a new and relatively advanced life form. We have much to thank them for because without them we would not exist.

This fossil is in the Welsh national museum in Cardiff. It is 3.57 billion years old and shows the first living organism to create oxygen. It was the action of these Stromatalites that made it possible for more complex life forms to come along later. All of our oxygen is produced by plants through the process of photosynthesis!

Have a look at the map below, produced by Global Forest Watch. The areas shaded in pink show points that have lost trees at least 16 feet in height due to deforestation, wildfire or some other cause between 2001 and 2015.



What effect will all of this deforestation have on global oxygen levels? Why?

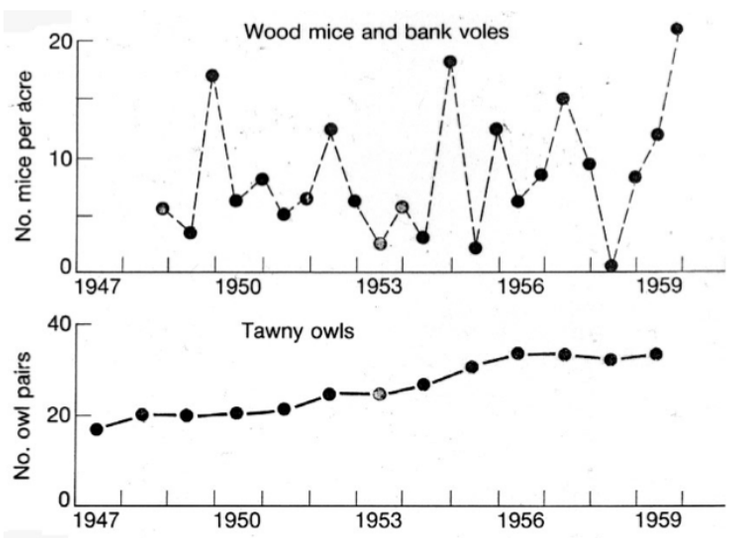
Activity 'Daisy World' is a video simulation created by James Lovelock and colleagues to show how the Earth functions as a self-regulating system. Watch the video and make notes before moving onto the next section of Unit 5, which focusses on the ways in which nature maintains balance: https://www.youtube.com/watch?v=XVB2VNxRuHM&t=5s

Just Like Riding a Bike!

Nature runs on a dynamic equilibrium. It sounds technical, but really it's just like riding a bike. To keep upright the rider makes constant adjustments, wobbling left and right to compensate for uneven ground and the shift in weight as the rider pushes on the left pedal and then the right. This constant adjustment happens almost unconsciously, and together with the forward momentum means the bike never falls over. Nature works in the same way: many different species interact with each other, spotting opportunities as they arise and withdrawing into safety when the they end. Mice and Owls are a good example of this natural balancing act in operation.

Small rodents become fertile at two weeks old and have a gestation period of 2½ weeks (staggering if you think about it!). If good conditions exits and there is an abundant supply of food a population of mice can multiply from one breeding pair to thousands in a matter of months.

This is turn might trigger a rise in population of owls - or any other predator - who quickly seize on such an opportunity to focus their attention on this new abundant food supply so they can begin raising young of their own. This, in turn, will affect the population of mice, which will dip in number as the predators become more reliant on them to feed. A dropping number of mice might then lead to the owls moving further afield to look for food, slowing their own ability to successfully raise new chicks.



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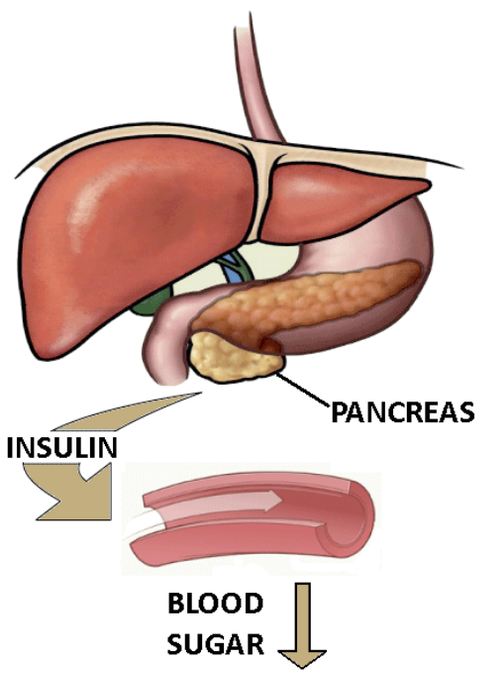
There is a similar kind of relationship going on in our bodies, helping regulate temperature, oxygen and sugar levels along with many other. This is known as homeostasis.

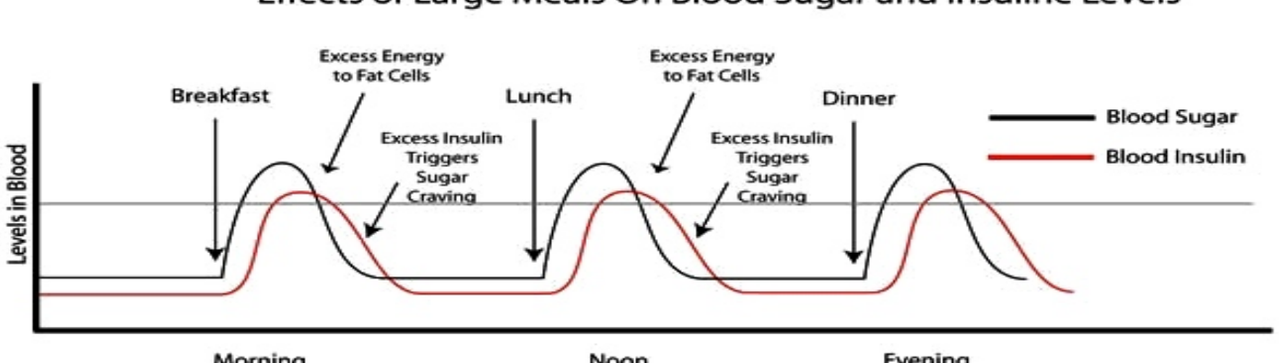
Definition of homeostasis:
a relatively stable state of equilibrium or a tendency toward such a state between the different but interdependent elements or groups of elements of an organism, population, or group (Merriam Webster Dictionary).

A rise in the blood sugar, following a meal is detected by a special part of our brain, and this stimulates the pancreas, an organ in the digestive system that produces the hormone insulin. Insulin stimulates our bodies to break down sugars, and to either use the energy or store it for future use.

As the body burns up the available sugars so the sugar level in the blood decrease, which in turn reduces the production of insulin. The drop in blood sugar also stimulates the hunger sensors in the brain, triggering behaviour to seek more food and thus raise the blood sugar level again.

This is called a negative feedback loop - where two variables are inversely linked. This is one of the absolute key ideas as to how nature works and as designers we are advised to bring this ability for systems to self regulate into our planning.





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Ecosystems

Ecosystems are much more complex, with many different species feedback and interacting with many others. The examples given above represent simplifications of more complex systems.

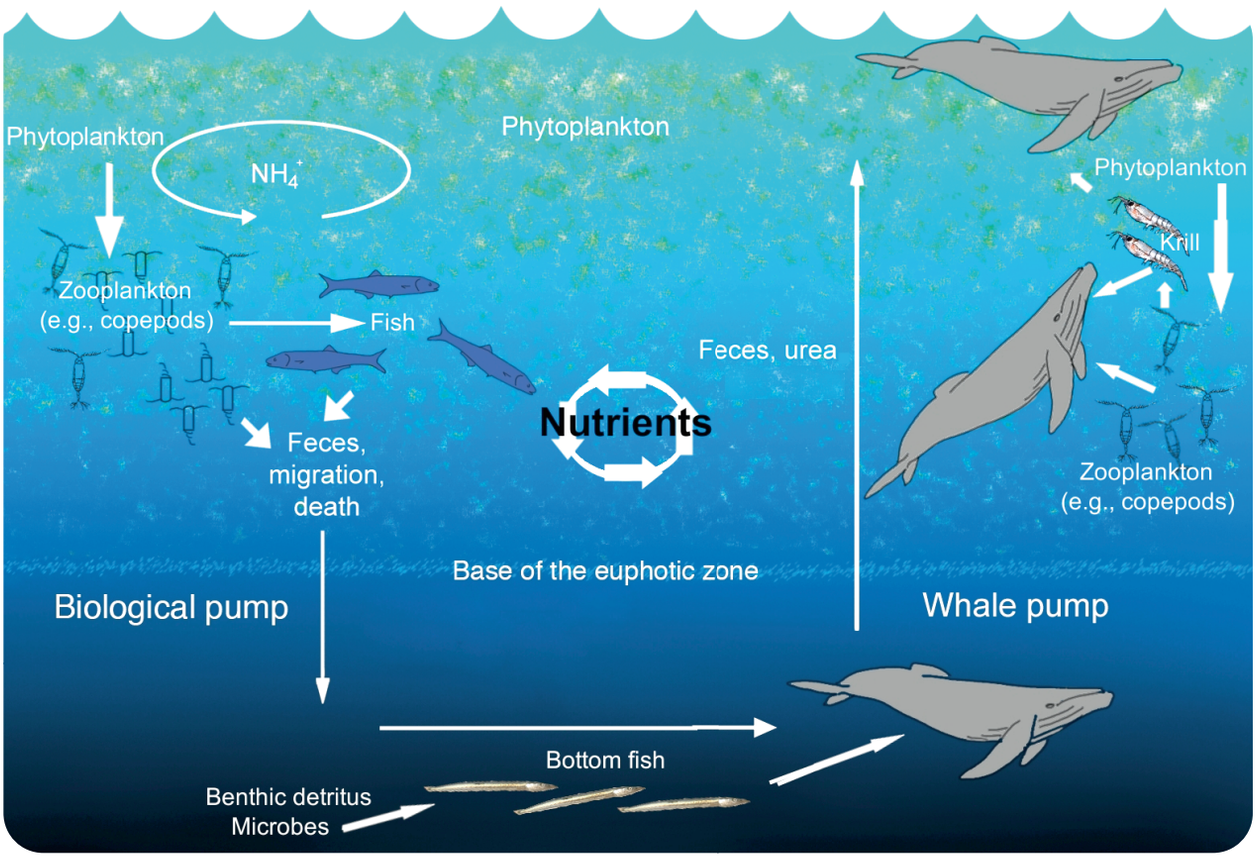
Definition of ecosystem:
the complex of a community of organisms and its environment functioning as an ecological unit (Merriam Webster Dictionary)

An ecosystem includes all of the living things (plants, animals and organisms) in a given area, interacting with each other, and also with their non-living environment (weather, earth, sun, soil, climate, atmosphere). Ecosystems are the foundations of the Biosphere and they determine the health of the entire earth system. In an ecosystem, each organism has its own niche or role to play.

More Whales = More Fish?

The largest mammals of all - whales - mainly eat large shoals of small fish, or krill - a kind of shrimp. Fishing nations such as Japan have argued that their practice of whale hunting regulates the number of whales, which in turn makes more fish available for humans to catch. What the whales don't eat leaves more krill to feed the smaller fish and therefore more for us humans to catch, so their argument goes. It does seem to make sense, that is until you consider how marine ecosystems work.

Whales actually play a very important role in marine ecosystems. Blue whales, for example, can consume vast quantities of krill, up to 40 million per day, which would quickly overpopulate an ecosystem if left unchecked. Whales also play a vital role in marine nutrient cycles, moving nutrients up and down between the surface and the sea bed. Whale's are also helpful in the amount of carbon they help to sequester. Sperm whale poo, for example, contains vital nutrients necessary for phytoplankton to thrive, which draw down carbon from the air in vast quantities through photosynthesis. Phytoplankton are also an essential source of food for fish, so the more phytoplankton in the ocean, the more fish!



The complex interactions between living things and their environment is the foundation of energy, carbon and nitrogen cycles, and consequently they have a major impact on the global climate. In the following video the journalist George Monbiot explains how whales and their role in ocean ecosystems have an influence on climate change. This is an excellent introduction to systems thinking and natural feedback cycles: https://www.youtube.com/watch?v=Wgmer_JXEM8&feature=youtu.be

Activity

It is possible to map out the connections in an ecosystem with a ball of string!

Choose an element in an ecosystem, e.g a fish in pond, a squirrel in a forest, plankton in the ocean, etc. Think of the inputs, outputs and functions offered by your element to the ecosystem. Sit in a circle and use the ball of string to trace the relationships between the elements of your chosen ecosystem. What do you notice about the pattern that emerges? Is it a simple pattern?

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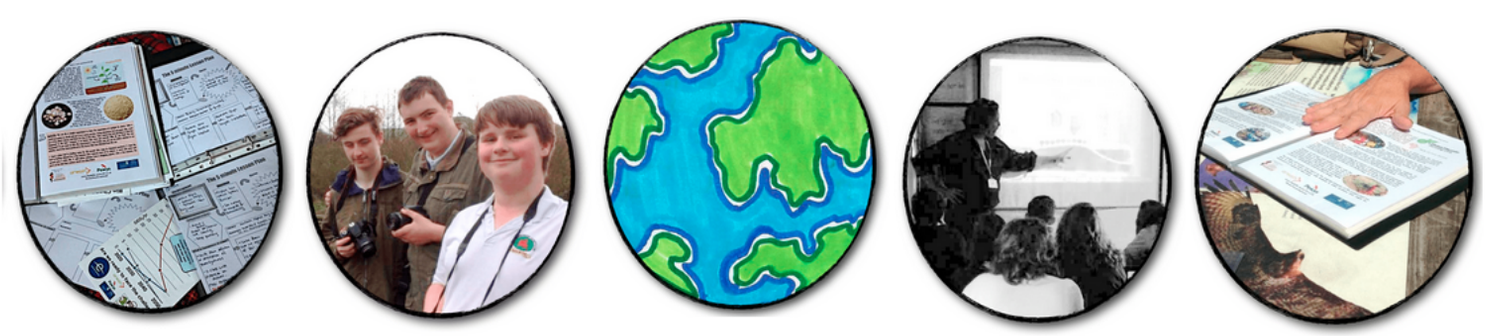


Unit 6:
Natural Resources

"Let nature take its course."

Natural Resources

This unit is about using and valuing natural resources and services. It may sound like an innocuous idea, but in many ways modern agricultural and technological developments have caused us to forget this rule. We take so much for granted!

Horse vs. Tractor? No Contest!

It is interesting to contrast the horse and tractor and to consider what that might mean in terms of how much our ideas of development have changed in less that one hundred years.

Powered by diesel, this brute of a machine can generate 700 horse power. With that phenomenal force there is very little it cannot do. It can plough, dig and reshape the land, pull huge loads, and can be driven by a single person who can learn the skills to use it after just a few weeks of practice and training. Having such machines has allowed farmers and builders to change and dominate landscapes to fit human needs. For many farmers and engineers it is almost impossible to consider using anything else.

Activity Draw up a table with two columns, one for strengths and one for limitations. Think about the tractor above and see how many strengths and limitations you can come up with.

Strengths	Limitations

Some of the problems with the tractor include: diesel is a finite resource, it causes pollution and has to be imported and refined in far away places. Tractors need maintenance and spare parts, which are often expensive to import. As powerful as they are, they make the farmer reliant on money and technologies that cannot be supplied locally.

Undeniably, tractors are great tools for setting up new systems, ploughing a new field, establishing new farms, building dams, roads and so on, but when they become the main tool for maintaining a system we end up becoming overly reliant on non-local inputs that are expensive and hard to replace.

Now consider horses. Horses can run on local resources, grass, hay, bran they don't complete with humans for feed and they produce manure which can be made into valuable compost from which we can grow more food. If the driver of the tractor falls asleep at the wheel he will most likely end up in the hedge, whereas the horse knows the way home! What other differences can you think of?

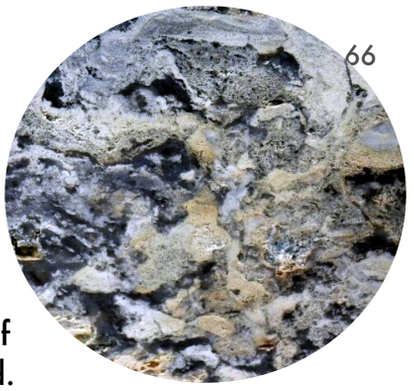
Admittedly, you can't hitch 700 horses to a single plough, even if you had that number of animals, but farmers who use draught animals tend to farm on a much smaller scale. They often work very locally and are particularly sensitive to the land on which they work and depend. Rather than changing it, or trying to dominate it, they are required to work with it. Small scale farmers may produce smaller yields, but they tend to produce much more per acre and cause less damage to the land.

Oil and Gas are Finite Resources

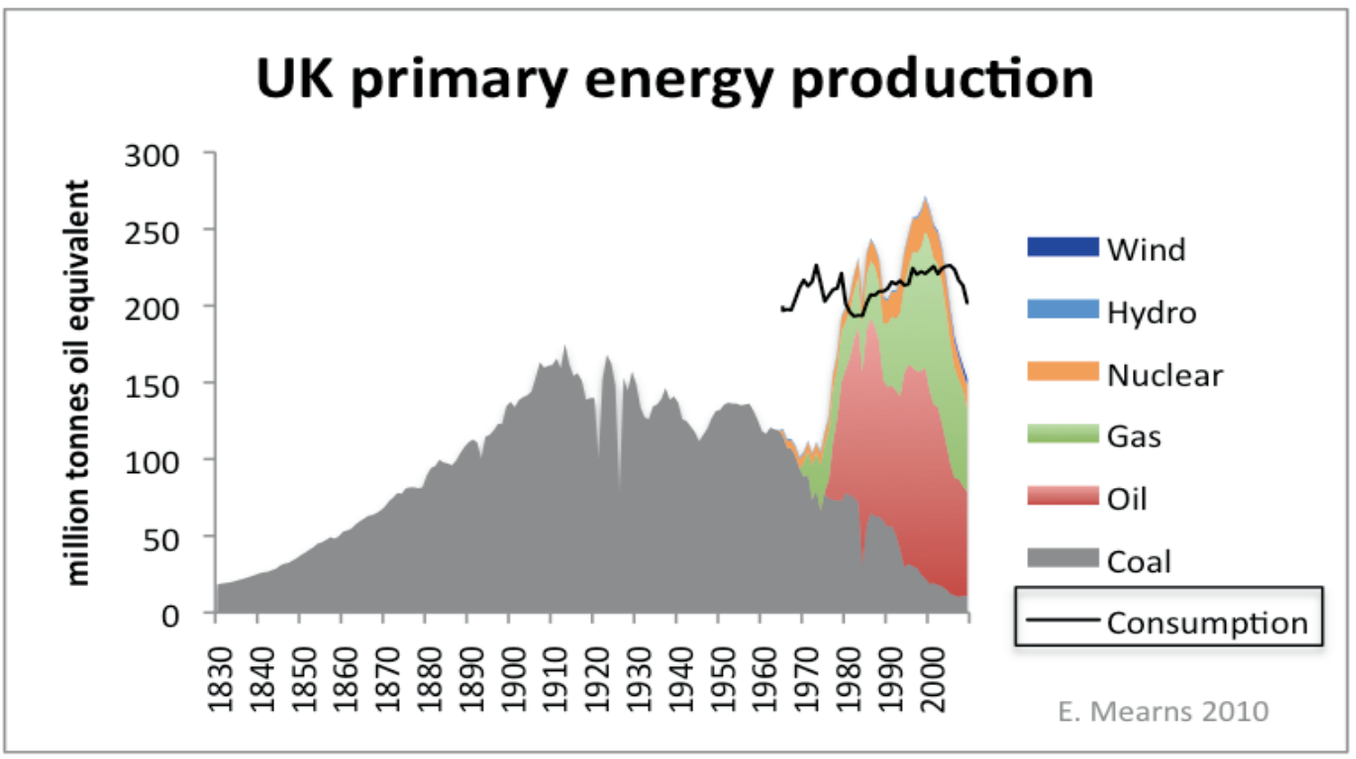
We have already talked about climate change and the role fossil fuels have played in causing significant changes to the Earth's atmosphere. We know that we have to move away from them for this reason, but there is another reason too - if that wasn't reason enough. As we dig deeper into the ground to extract oil and gas the amount of energy taken by drilling goes up so that the energy value of the resource goes down. This is called the law of diminishing returns in economics.

Oil companies have, naturally enough, extracted the easier-to-reach, cheap oil first. The oil pumped first was on land, near the surface, under pressure, light and 'sweet' (meaning low sulfur content), and therefore easy to refine. The remaining oil is more likely to be off-shore, far from markets, in smaller fields and of lesser quality. It therefore takes increasing amounts of money and energy to extract, refine and transport.

Under these conditions, the rate of production inevitably drops. Furthermore, all oil fields eventually reach a point where they cease to be economically, and energetically viable. If it takes the energy of one barrel of oil to extract another barrel of oil, then further extraction is pointless, no matter what the price of oil.



So, oil may never run out, but extracting and refining it will cost more and more per barrel. There is a very real problem developing and it is that oil companies need the price of oil to be about US$75 dollar a barrel to make a decent profit but at that price the consumers and the economy can't afford it and they tend to go into debt. So neither position is sustainable in the long run. We are rapidly running out of cheap and easy ways of extracting oil, much faster than we will run out of oil in the ground.



300 Years of Fossil Fuels in 300 Seconds

Fossil fuels have powered human growth and ingenuity for centuries. Now that we're reaching the end of cheap and abundant oil and coal supplies, we're in for an exciting ride. While there's a real risk that we'll fall off a cliff, there's still time to control our transition to a post-carbon future. Watch the following five minute video, created by the Post Carbon Institute, for a lightning quick overview of 300 years of Fossil Fuel consumption: https://www.youtube.com/watch?time_continue=45&v=cJ-J91SwP8w

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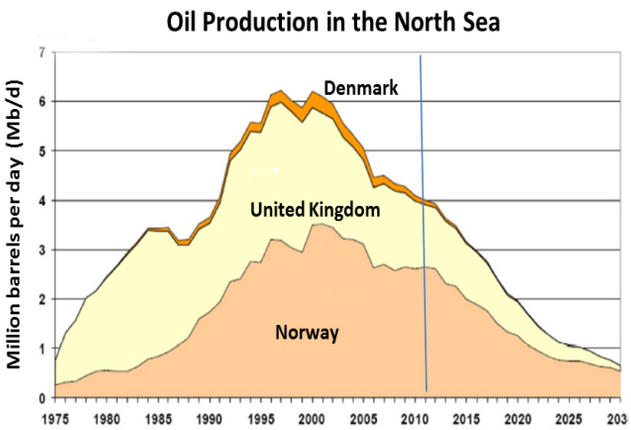
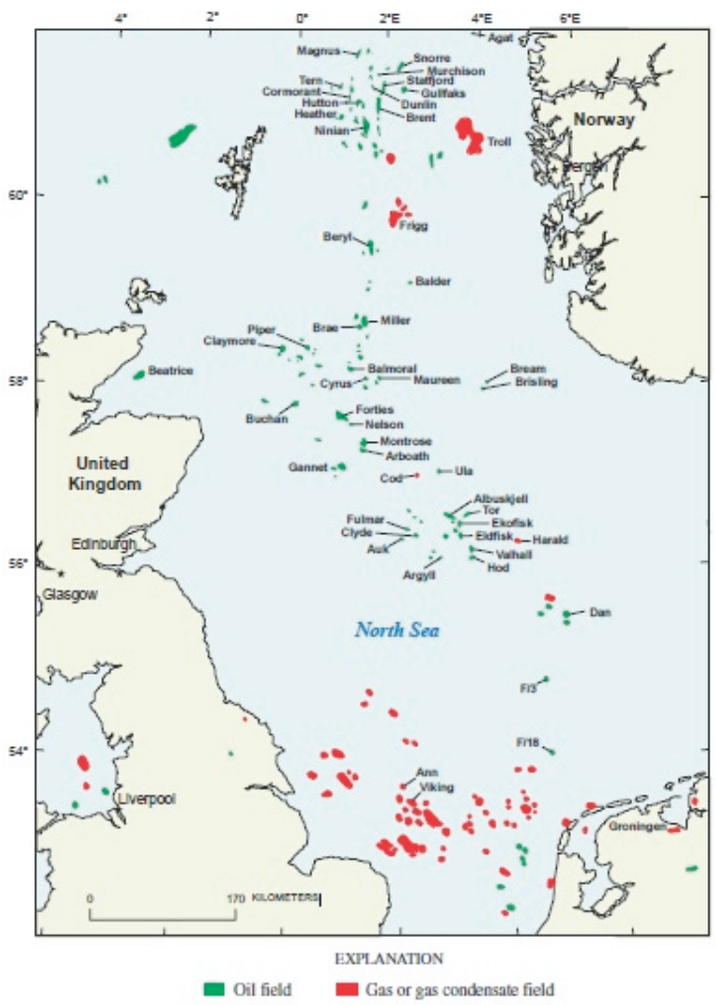
A Brief History of Energy in the UK

When Britain was Great we were mainly powered by wind as a sailing nation. The shift to coal marked the industrial revolution which peaked in 1907, just before the First World War. At this time Winston Churchill, who was then head of the Navy, decided to commission the next generation of war ships, these would be powered by oil. This amazing new fuel - that was in liquid form and energy dense - was much better than coal. The problem was, however, that the UK did not have any oil of its own. From this point onwards, foreign policy switched to an emphasis on controlling the shipping routes to Saudi Arabia and the rest of the Middle East, which is where most of the world's oil is found. These decisions still have big repercussions today, and are behind many of the conflicts now arising in the region as different nations jostle for access to these remaining resources.

North Sea Oil

When oil was discovered in the North Sea, Britain had the opportunity to join the powerful oil exporting nations for about twenty years, but that supply has been depleted and is tailing off rapidly. The North sea oil companies are now receiving grants and tax relief from the government to keep them profitable as supplies diminish.





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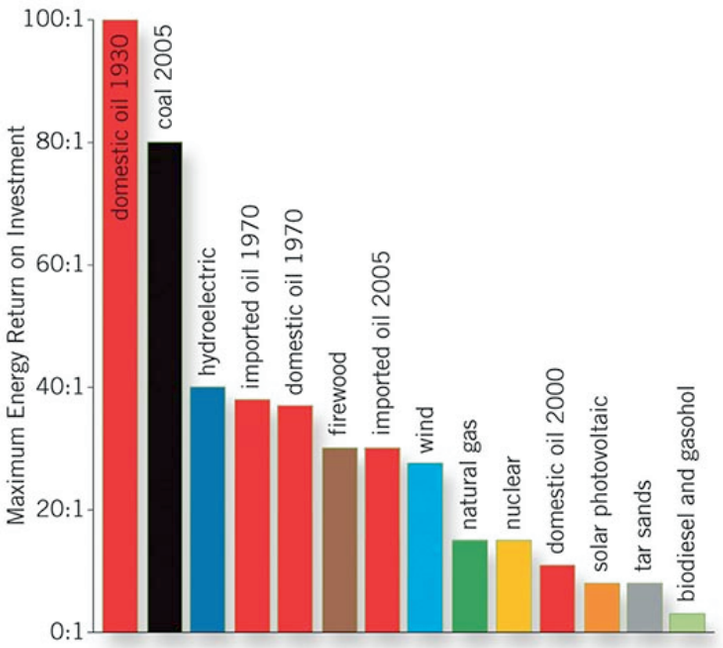
EROI is the Measure for Energy



Energy is a big subject and can be quite difficult to understand. In fact, most people - even politicians! - don't fully understand the problem. But there is a simple way to understand it and to make comparisons. It is a simple calculation called Energy Return on Investment (EROI). People ask the question how much energy is there, will it ever run out, and the answer is there is loads of energy and it will never run out! But that is actually the WRONG question to ask. Why?

There is No Such Thing as Free Energy

Consider a solar panel up on your roof humming away on a sunny day creating electricity. Is this free energy?

The answer is: No, because it takes energy to make a solar panel and to put it up on the roof. Then, over time, the panels become less efficient and things wear out so that eventually it has to be replaced.

So it is not *free* energy, but overall the energy it produced in its life time is much more than it took to make it.

Energy from renewables like wind and solar are the best bet for meeting our future energy needs. Nevertheless, they also present us with a problem - they only provide

electricity. Electricity is very useful in the home, but most of our agricultural and transportation infrastructure runs on diesel - tractors, pumped water for irrigation, freight shipping and more are all powered by oil derivatives. The fertilizers and pesticides used in industrial agriculture are also made from oil derivatives.

The reality is that future farming will have to move to an almost entirely organic system, using a combination of techniques that are also good for nature and help sequestrate carbon back into the ground.

No More Cars After 2040?

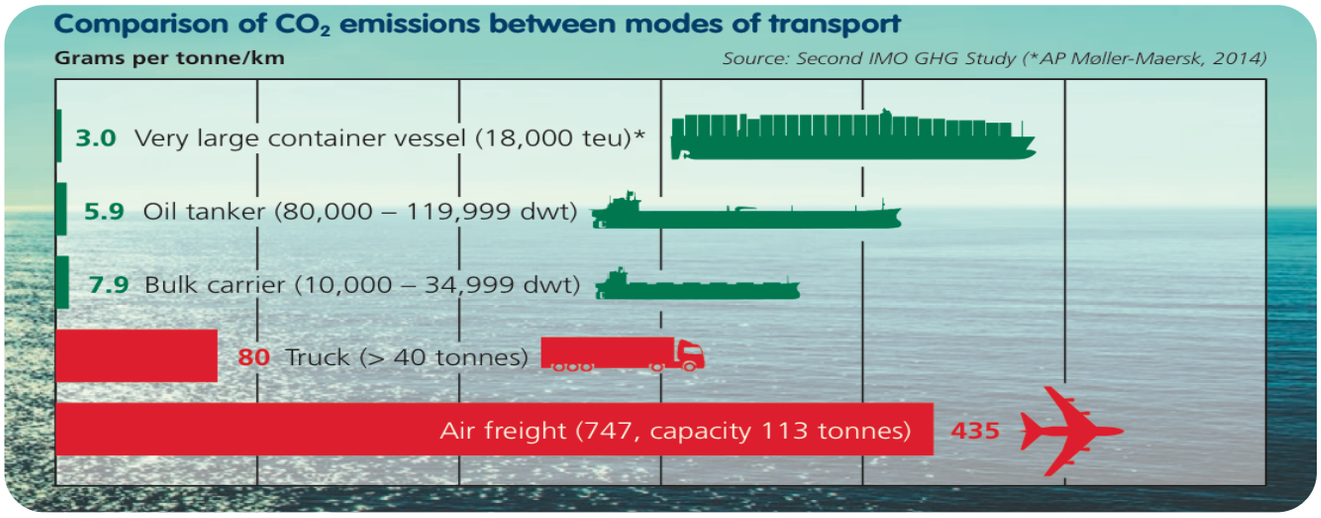
Britain to ban sale of all diesel and petrol cars and vans from 2040

Source: *The Guardian*, 25th July 2017

The UK government has already announced that my 2040 we will be phasing out the internal combustion engine, but in reality it will have to disappear much sooner than that. Sharing cars and coming up with much more flexible transport options and more localised ways of doing things will be a big part of the solution, but we will have to begin to think and plan very differently than we do today.

Driverless cars, electric car sharing and electric taxis will become the cheapest forms of transport in cities, even cheaper than using your own car, but in a rural area like Powys the challenges will be harder as we are a very dispersed population.

Activity Changes like these are going to affect every level of our infrastructure, right from the way that farmers produce crops, through to the way we travel around the country and even how we get in to school. Be as creative as possible and try to come up with a solution for getting students into school in a world with no petrol cars, vans or busses. What would you do?



This graph compares different kinds of freight transport in terms of how much carbon dioxide they emit per tonne of goods moved a kilometer. What does it tell us about the future of freight transport?

It tells us that the future for transport is big and slow. Fast forms of transport like jet planes are very useful, but in terms of moving freight around the world they are likely to become prohibitively expensive very soon.

This will have a big impact on how we import and export goods. The reality is that we will only be able to transport goods that have a high value and that don't go off very quickly - goods that have a long shelf life. So, yes to importing coffee and no to importing water melons.

Summary

Our over reliance on fossil fuels for everyday activities - such as traveling to and from school, popping into town for shopping, going abroad for holidays - is going to have to come to an end. It doesn't mean that we have to turn back the clock and live like our ancestors, but it does mean we will have to develop a new respect for the resources we have at our disposal, and reassess the importance of the many things we take for granted!

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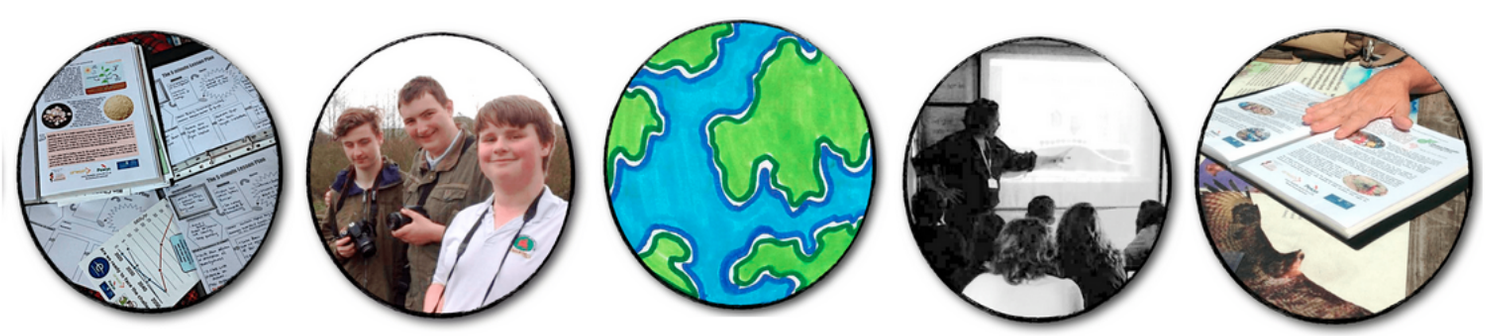


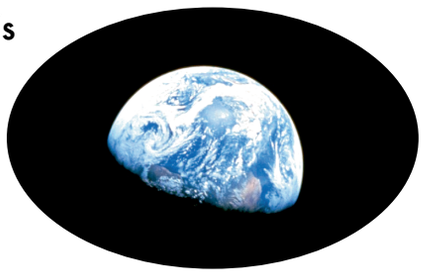
Half-Way Point

Applying What We Have Learned So Far

Now that we have covered the first six units we have arrived at the half-way point of this programme. In Booklet 2 we will be starting to think about the practical implementation of some of the ideas we have discussed so far.

Over the last six units we have seen how **change** is an inevitable part of life that we must creatively respond to. That solving problems requires **observation** of the world around us. That the natural world functions through **catching and storing energy** to produce an abundance of **yields**. That the Earth is a self regulating system (of which we are a part) that operates through **feedback loops** and is subject to **limits**, and that if we want to reverse the negative impact of human activity on the global ecosystem we will have to change the way we use and think about **natural resources**.

We have covered a lot of theoretical ground here (and there is still more to come), but the units in Booklet 2 increasingly emphasise the practical application of these key ideas through **design**, **innovation** and **community action**. Above all, the units that follow encourage a different way of thinking about our role in the Earth's dynamic system, and how we can incorporate this new way of thinking into our daily lives:



Unit 7 - Waste Not
Unit 8 - Patterns
Unit 9 - Integrate
Unit 10 - Small and Slow
Unit 11 - Diversity
Unit 12 - Edges

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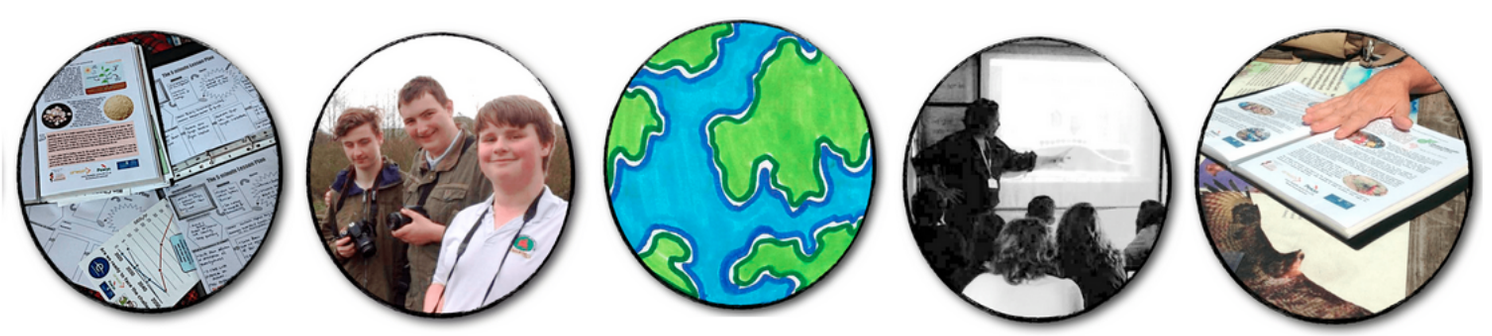


Zone Zero

www.sector39.co.uk/zone

Documents Videos Slideshows

Zone Zero is the One School One Planet Moodle site.
Visit the address above and sign up to get access to our teaching resources.

The following pages contain a list of useful resources to accompany the teaching of Units 1-5.

Unit 1: Creatively Use and Respond to Change

	IPCC Factsheet	Factsheet with key information on the Inter-governmental Panel on Climate Change (IPCC).
	We Aren't Doomed by Climate Change	Provocative and thoughtful article, 'we are choosing to be doomed by our inaction.' What are we waiting for? If we know that we have to change then we would be wise to embrace that change and soon as possible. This article is well worth the read, it puts a lot things into perspective.
	WWF Living Planet Lecture 2016 (57 minutes)	This really is a must watch for anyone thinking seriously about the change to come. Sir David Attenborough & Professor Johan Rockstrom speak at WWF UK's Living Planet Lecture 2016. This one hour lecture sets out clearly the realities of climate science and what we must do to avoid a catastrophe in plain English.
	13 Year Old Severn Suzuki Speaks at Rio Earth Summit, 1992 (8 minutes)	In 1992 the World held its first global environment summit in Rio de Janeiro. It was a highly significant moment and gained world media attention and established the words 'Sustainable' and 'Sustainability' in the global lexicon. 13 year old Severn Suzuki caused a storm of interest with her speech at Rio Earth Conference in 1992. It is interesting to hear these words today and to consider how much if at all she was listened to.
	Experts and Empirical Evidence, Prof. Brian Cox Talks Climate to a Denier (29 minutes)	This is an edited episode of ABC's Q&A show "Experts and Empirical Evidence" (15/8/2016). The climate debate has flushed out many opinions, this excellent TV panel debate illustrates exactly the discussions between science, politics, none scientific commentators and the coal and oil industry representatives. If you want to understand how so much time has been wasted talking about problems rather than acting on them then this gives you a good idea.

Unit 2: Observation

	What is Science? - Richard Feynman	If you enjoyed the Brian Cox video above then you might enjoy reading this. Feynman was truly a genius. He had a wonderful enquiring mind and an infectious enthusiasm for science, he could really communicate as well. Feynman was a Nobel winning scientist, and one of the greatest minds of his generation. For anyone even slightly interested in science it is a great pleasure to read his words, here he is in action.
	School Garden for Busoga High School	Busoga High School in Eastern Uganda has been linked to Llanfyllin High School for many years (see the plaque in the reception area). In May 2017 Sector39 worked with teachers at the school to design and install a permaculture garden that harvests rainwater run-off from the class room, and uses waste organic matter to feed the soils.
	The Chikukwa Project (52 minutes)	This is an excellent and inspirational story of one of the most successful development projects in Africa, initiated by the community themselves and with out international support.
	What is Science? - Science is Observation (5 minutes)	Does your theory agree with the experiment? Ideas are tested against nature and the outcome proves or disproves the theory. In other words, science works on feedback. In this short clip Prof Brian Cox introduces us to Richard Feynman's explanation of what is science?

Unit 3: Catch and Store Energy

	Water and Soil	An introduction to soil composition, water and nutrient cycles and other soil processes.

	Dirt: The Movie (60 minutes)	Join us on an excursion into the realms of soil, the number 1 lifegiver on Earth. The video outline of soil's fundamentally important ecological functions and our poor understanding of it, as well as our destructive relationship with it. We need to understand soil much better in order comprehend life on earth. Without this insight we won't be able to make the changes necessary for our survival. This is an excellent documentary and features some of the most influential voices in this subject area.
	Greening the Desert (8 minutes)	This short video contains the original Greening the Desert film by Geoff Lawton that went viral when it was first released. Permaculture hit mainstream attention with this video and it beautifully illustrates how passive water catchment can totally transform even the most arid of areas.
	Water Cycle Experiment (7 minutes)	Pure genius. This brilliant short video illustrates the importance of keeping soil covered and its impact on water infiltration, groundwater recharge and flooding
	Water Harvesting with Geoff Lawton (60 minutes)	Permaculture began in Australia, a continent where most of the rain falls at one time, so it is not surprising that rainwater catchment and retention is central to planning in permaculture design. 'You don't miss your water 'till your well runs dry' goes the song, and when we talk about catching and storing energy water is the key thing to think about. This hour long video is the detailed story of a single dam building project and gives a really clear idea about the tools and strategies needed to approach such a challenge.

Unit 4: Yields

	Saving Britain's Food Supply	"If you can't feed a country, you haven't got a country." Guardian article on the economics of local food. Brexit imperils the health of a nation whose food supply was already under threat from climate change and shifting global markets. Here, Jay Rayner - the Observer's restaurant critic - outlines how we might avert disaster.
	Permaculture is a Poly-Culture (30 minutes)	Nature doesn't adhere to mono-crop systems. Natural systems are diverse and interconnected. When it comes to understanding yields in nature we need to take a broader view than what we do in our human commercial world. This video brings the world of Sepp Holzer to life. He and his wife Margaret have converted 40 hectares of Austrian mountain slopes into a productive and diverse farm. Yields of fruit, vegetables, livestock, fish, plants and more. All of this productivity is augmented with wildlife and conservation talks, and eco tourism.
	How Farming Can Reverse Global Warming (22 minutes)	Take carbon from the air, put it in the ground. The Organic "Green Revolution" fix-it. Timothy J. La Salle grew up inside the agro-industrial farming sector before realising the damage it was causing to the environment. This is an essential lecture for anyone interested in the power of soil in facing our greatest challenge.
	Morag's Permaculture Garden (33 minutes)	A video of Morag Gamble, from Crystal Waters Australia, giving a guided tour of some of her favourite plants in her permaculture garden. Her informal tour of the garden gives insight into the many perennial and self seeding plants that can be used in edible landscape design.
	A Brief Introduction to Bio-Char (5 minutes)	An introduction to bio-char, what it is, what it does, and how it can help to tackle climate change and make our gardens more fertile and productive.

Unit 5: Limits and Feedback

	What is the Evidence for Evolution? (11 minutes)	A short video introduction to the theory of evolution focussing on the evidence that backs up the theory.
	How Whales Change the Climate (4 minutes)	An excellent short video narrated by George Monbiot explaining how the ocean's ecological system works. This is a great introduction to systems thinking and feedback loops in nature.
	How Wolves Change the Course of Rivers (4 minutes)	When wolves were reintroduced into Yellowstone National Park in the United States - having been absent nearly seventy years - the most remarkable "trophic cascade" occurred. What is a trophic cascade and how exactly do wolves change rivers? George Monbiot explains in this movie remix.
	Daisy World (6 minutes)	We can gain a better understanding of feedback processes of ecological systems with this simple model, proposed by James Lovelock, originator of the Gaia hypothesis
	Everything is Connected (3 minutes)	Farmer Managed Natural Regeneration is an approach which World Vision uses to restore degraded land in projects throughout the world. The practice of FMNR can increase crop yields, firewood and livestock fodder. It can diversify household income sources through the sale of excess tree and non-tree products. It also has the ability enhance resilience to climate change and extreme weather conditions. Learn about all the benefits of FMNR in this video.

Unit 6: Natural Resources

	Energy	The shift from non-renewable to renewable energy will be the story of the coming decades. We need to get a better handle on energy to understand it. This slideshow takes you through the basics, and is the foundation resource used on the Sector39 PDC to discuss core energy matters.
	Restoring Landscapes with Bamboo (15 minutes)	Charlotte O'Brien, Director of Bio Bamboo and CO2 Drawdown Solutions, explains how to significantly draw down Carbon from the atmosphere and sequester it as a Bio-Char soil conditioner using Bamboo to fuel Pyrolysis. Adding the Bio-Char to depleted soil fosters the spread of Mycorrhizal fungus in the soil, which in turn creates Glomalin (which sequesters even more Carbon). The enriched soil then produces more biomass which can be processed into more biochar...the result is an exponential carbon draw down! The process also generates a bevy of marketable bi-products.
	300 Years of Fossil Fuels in 300 Seconds (5 minutes)	Fossil fuels have powered human growth and ingenuity for centuries. Now that we're reaching the end of cheap and abundant oil and coal supplies, we're in for an exciting ride. While there's a real risk that we'll fall off a cliff, there's still time to control our transition to a post-carbon future.
	The Law of Diminishing Returns (3 minutes)	In this new short video Richard Heinberg explores how — in our economy, the environment, and energy production — we may well be. When previous societies have hit similar limits, they often doubled-down by attempting ever more complex interventions to keep things going, before finally collapsing. Will this be our fate too? And is there an alternative?

	**The History of Oil** (45 minutes)	Genius, a stand up comedian turns his analysis to recent history. Robert Newman gets to grips with the wars and politics of the last hundred years - but rather than adhering to the history we were fed at school, he places oil centre stage as the cause of all the commotion.

Biographies

Steven Jones is a passionate and articulate teacher and practitioner of permaculture design with extensive knowledge of both the theory and practice of sustainable development. More than 25 years of hands-on experience implementing and project-managing land-based initiatives, such as community gardens, small farms and sustainable housing cooperatives underpin Steve's expertise. Steve has worked as a member of the Center for Alternative Technology in Machynlleth, and as a member of the *Get-Growing* team in Newtown, Powys, which supports the development of community food growing projects. He has also worked as a consultant to the *Squash Nutrition* urban food growing project in Liverpool. Steve is a certified Business Studies and Economics teacher and has a degree in Sustainable Development from the University of Reading, which bring depth and professionalism to his teaching approach. He maintains several blogs and is an avid networker and communicator on the subjects of sustainability, transition and co-operatives. With his colleagues at *Sector39*, Steve delivers up to six on-site permaculture design certificate courses per year alongside numerous shorter courses, including on low-impact structures, and introductions to permaculture and forest gardening.

Visit www.sector39.co.uk for more information.

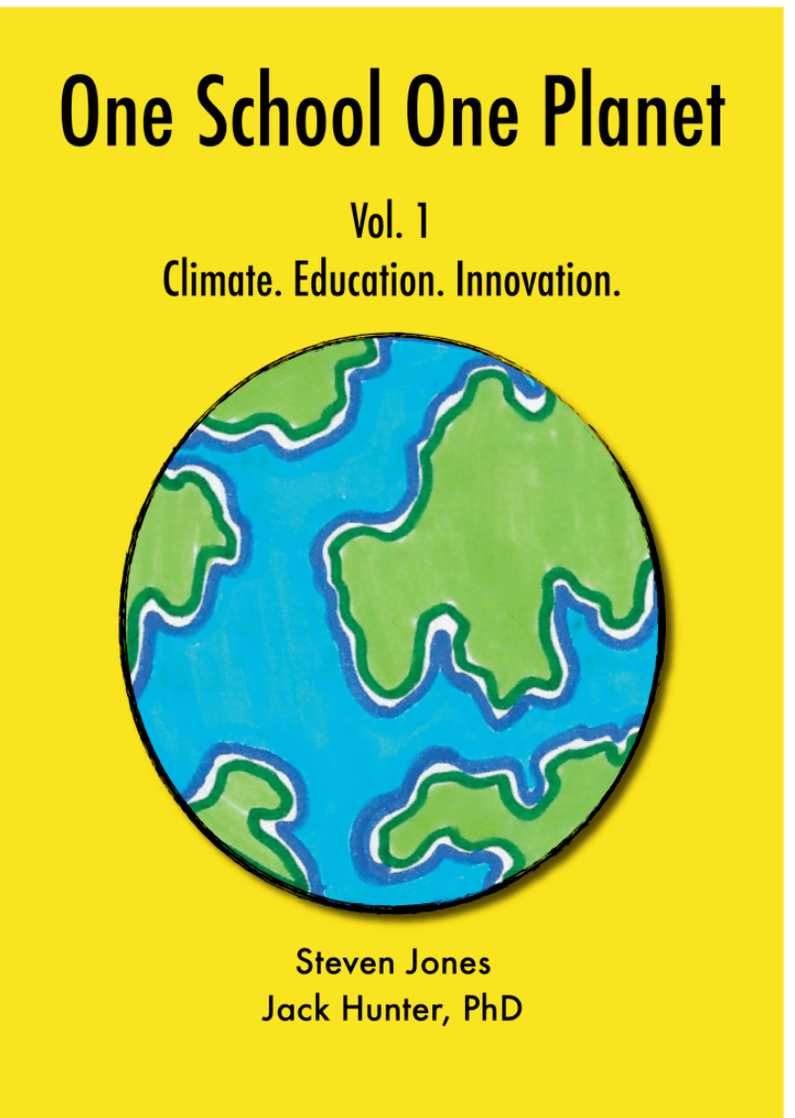
Jack Hunter, PhD is an anthropologist exploring the borderlands of ecology, consciousness, religion and the paranormal, living in the hills of Mid-Wales. His doctoral research with the University of Bristol examined the experiences of spirit mediums and their influence on the development of self-concepts and models of consciousness. He is the founder and editor of *Paranthropology: Journal of Anthropological Approaches to the Paranormal*. He is the author of *Why People Believe in Spirits, Gods and Magic* (2012) and *Engaging the Anomalous* (2018), editor of *Strange Dimensions: A Paranthropology Anthology* (2015), *Damned Facts: Fortean Essays on Religion, Folklore and the Paranormal* (2016), and co-editor with Dr. David Luke of *Talking With the Spirits: Ethnographies from Between the Worlds* (2014). He is a lecturer in Sociology and Psychology at North Shropshire College, and teaches modules on Education, Criminology and Abnormal Psychology. He completed his Permaculture Design Course at Chester Cathedral in 2017. He is particularly interested in exploring the possibility of an alternative way of engaging with and understanding the landscape and environment, informed by his anthropological research and interests, in particular through explorations of animism, folklore, systems thinking and deep ecology.

Visit www.jack-hunter.webstarts.com for more information.

Also Available:

"It is exciting to discover a Welsh community that has already done so much to pioneer…practical solutions using permaculture design… Prepare to be inspired."

– Maddy Harland, editor of *Permaculture Magazine*.



This short book lays out some of the big ideas that underlie the One School One Planet project, and tries to present them in accessible bite-sized chapters that can be read as a continuous narrative, or dipped into individually for snapshots of different ways of thinking.

The chapters build up to the first trial sessions of our educational programme with students at Llanfyllin High School, and the book includes many examples of their writing and artwork.

We hope that through presenting our work in this way we can encourage others to pursue similar goals in their own local communities.

The book also makes an excellent companion text to accompany our schools programme.

To get hold of a copy visit:

http://llanfyllin.sector39.co.uk/book